THE WEEK'S EVENTS

USHA Clarifies Land Policy

Answers charges by New York official that cost limit hinders slum clearance

Answering charges by Chairman Alfred Rheinstein of the New York City Housing Authority that requirement by the U. S. Housing Authority of a cost limit of $1.50 per sq.ft. on land seriously interferes with slum removal, Nathan Straus, USHA administrator, stated Oct. 20 that USHA was prepared, under certain circumstances, to go beyond this cost limit.

Straus emphasized that the $1.50 cost limit was not a new policy but has been in force unchanged for nearly a year. "In cases where the local authority believes that it is wise and sound policy to pay higher prices for land," Straus said, "the USHA will bear a part of the excess cost."

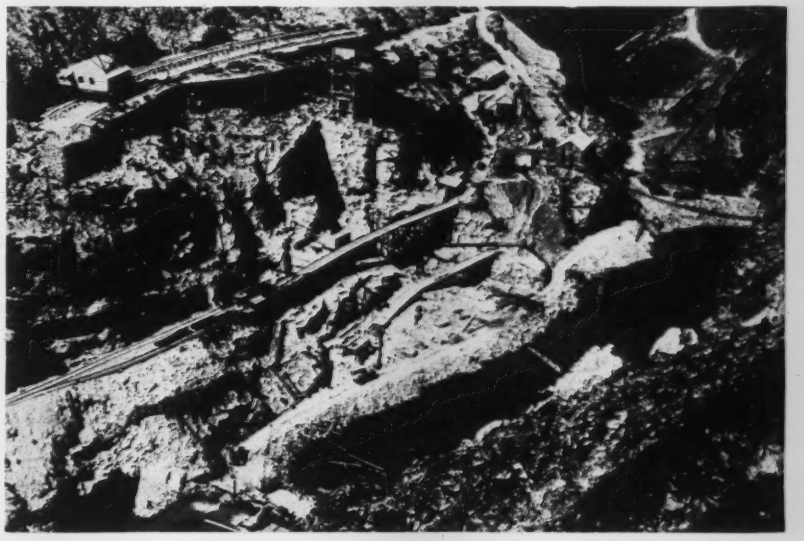
"The figure that has tentatively been discussed is that one-third of this excess shall be borne by the USHA and two-thirds by the locality."

In a letter to the New York *Times* on the same subject, Straus said, that "if such a peculiar local condition [justifying larger expenditures for land in New York City] exists—and there is good reason to believe that it does—then it is fitting and proper that . . . it be met by a special local contribution. Such local contributions are the surest safeguard against inflation of land values that ought to be deflated."

Difficulties in New York

Rheinstein's statement, made public Oct. 19, said that the New York commissioner had been trying for some time to have the order changed. He said that the existence of this limit made it impossible to build housing projects in the congested slum areas of New York where land values are high. The two projects now under construction under the USHA program are in special areas with low land costs, but Rheinstein pointed out that it is doubtful whether even outlying projects would be feasible in the future. "In such cases," he said, "the city would have to spend such large additional sums for streets, schools, playgrounds, sewers and other services close to the new housing that it hardly would be worth while to accept the federal loans and grants."

"The only alternative seems to be to decline further federal aid on this new basis and just carry on with city and state funds."



Wide World

WORK PROGRESSES AT RUBY DAM

UPPER AND LOWER cofferdams are under construction at Ruby Dam, hydro-electric structure being built on the Skagit River by the municipally-owned utility at Seattle. The downstream portal of the diversion tunnel is visible at the lower left.

Ruby Dam will be a gravity-type structure, arched in plan, 640-ft. high. A preliminary unit, comprising an arch dam 250-ft. high, is to be completed next year. This first unit will be incorporated later in the high gravity dam.

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Seattle Pontoon Bridge Gets PWA Grant

The Washington State Toll Bridge Authority has received a grant of $2,241,000 for the $8,350,000 Lake Washington pontoon bridge project. An earlier PWA grant of $1,500,000 for a six-span bridge over the lake can be diverted to the pontoon project.

The job involves a concrete pontoon bridge across the lake, a tunnel at the Seattle approach, and a four-lane highway into the heart of the city with underpasses and overpasses at streets.

Court Will Not Review Status of Consultant

The U. S. Supreme Court on Oct. 24 refused to review a Circuit Court decision which held that the late Joseph B. Strauss, engineer for the Golden Gate Bridge and Highway District on the Golden Gate bridge, was an independent contractor rather than an officer of the district.

Strauss, who was made engineer for the bridge in 1929 under an arrangement by which he was to receive 4 per cent of the estimated cost, had deducted payments made to him by the district from his income tax report on the ground that the salary of an officer of a state instrumentality is immune from federal tax. The Board of Tax Appeals agreed that district employees are immune from taxation, but held that Strauss was not actually an officer of the district, but an independent contractor By refusing to review, the Supreme Court accepts finding.

SALVAGE AND TEMPORARY REPAIRS UNDER WAY AT FORT PECK DAM

TO PROTECT the damaged area at Fort Peck Dam from a possible rise of the reservoir during next spring's floods, a hydraulic fill levee is being pumped into the slide section upstream from the core. This view, looking from the east abutment across the slide area to the upstream face of the dam, shows three dredge pipelines in place for the levee: one is in the foreground, another is discharging at the extreme left, the third is just below the undamaged section at the far end of the slide area.

Salvage of equipment and riprap lost in the slide is under way at the left. Also in view are several of the core and calyx drill rigs being used for soil investigations to determine the cause of the Sept. 22 slip. The corepool pump barge at the extreme right, in what was the core section before the slide, is in position for whatever operations are decided upon after completion of the soil investigations.

Housing Cost Reaches New Low

Bids on two Austin projects show cost a third lower than in New York City projects

Opening of bids on two housing projects in Austin, Texas, indicated that, on the basis of the low bid, the average construction cost per family dwelling unit would be about $2,200 and the cost per room $650. This is about a third lower than the cost of $3,350 per dwelling unit achieved in the Red Hook project at New York City and of $3,506 at Buffalo. Cost per room on the two projects were $811 and $823, respectively.

The Austin project consists of 40 fireproof one-story row houses with concrete slab floors and masonry walls for Mexican families and of 60 similar dwellings for Negro families. Dwelling units will range in size from 2½ to 5½ rooms. Rents proposed on the project will range from $7 to $15 per family per month.

Commenting on the cost figures, Administrator Straus of USHA pointed out that "the costs achieved by the Austin Housing Authority are based on exactly the same figures as those contained in the costs of private construction quoted from time to time. . . . Into these costs have entered the fact that prevailing wages will be paid to labor and that in all cases the projects will be designed to last for 60 years."

Additional 90-per cent loans to local housing authorities totaling $29,615,000 were approved by the President Oct. 29. This brings the total of loans approved to $232,422,000.

The new loan contracts will provide about 5,863 family dwelling units. The largest of the new loans is $9,877,000 made to Pittsburgh; USHA has already signed a contract for a loan of $6,746,000 to this city. Chicago received its first housing money with a loan of $8,674,000.

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Land Use Survey For Chicago

The sum of $1,653,000 has been allocated by WPA to start a land use survey and real property inventory for Chicago. Similar surveys have been made in numerous other American cities, where, however, they have all been confined to residential property. The Chicago survey will cover commercial and industrial as well as residential.

The City of Chicago is the sponsor of the survey. The work will be supervised by the Chicago Plan Commission, under the immediate direction of its chief engineer, Hugh E. Young. Harry S. Cutmore has been selected to direct the work, which falls within the jurisdiction of H. K. Seltzer, district director of WPA.

The survey will produce data as to the physical condition and the use of all land and buildings in Chicago. These data will be the basis for determining the extent of rehabilitation needed by sub-standard city areas.

Fort Peck Allotted Additional Funds

Slide delays completion of project until 1940—soil investigations being made

The War Department on Oct. 24 allotted an additional $2,000,000 for continuation of work on the Fort Peck Dam being built by the Army Engineers on the Missouri River in Montana. Originally scheduled for completion in 1939, work on the project will now continue into 1940 because of the slide that occurred in the upstream face on Sept. 22, when some 8,000,000 cu. yd. of material slumped into the partly-filled reservoir. The delay in completion, however, will not interfere with the storage of water, which started last spring.

Soil investigations are now being made to determine the cause of the slump and to aid the determination of procedure in repairing the break. On Oct. 19 eight core and churn drills were in operation, drilling holes from 4 to 36 in. in diameter up to 125 ft. deep. At that time 31 smaller holes had been completed and 30 more were planned; seven large holes are being drilled in the damaged area by hand and calyx methods. Local freezing is used where necessary to get the larger holes down through soft material.

A hydraulic-fill levee is being pumped into the slide area upstream from the core as a protection against possible floods next spring. Cranes and trucks are busy salvaging equipment, ma-

terials and riprap carried out by the slide. Two draglines, two tractor cranes, three tractors, and most of the railroad track and pipeline have already been recovered. Normal filling operations have been resumed in the parts of the dam not affected by the slide.

A high spot in the emergency operations following the slump was the building of 12,500 ft. of railroad up and across the downstream face of the dam in three days. The new line, built to provide rail access to the west upstream face for riprap haul, starts at the east abutment on the downstream side and climbs on an average grade of 2.3 per cent to the present crest at the west abutment, then switches back down the upstream face. This line replaces 10 miles of line around by the spillway, formerly used for stone haul to the upstream side but which was partly swept away by the slide.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $53,634,000, are 18 per cent below a week ago and 15 per cent below the corresponding week in 1937. This is the first time in the past 15 weeks that awards have fallen below their 1937 value. The week's construction volume, although lower than last week and last year, is 3 per cent higher than the 1938 weekly average, and 11 per cent higher than the average for the 43 weeks in 1937.

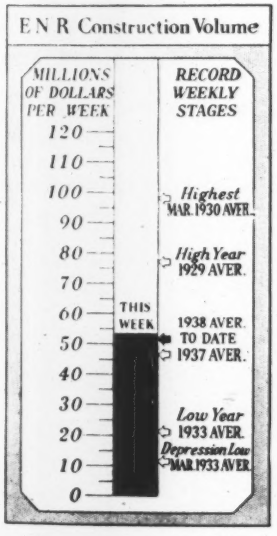
Construction awards for 1938 to date, $2,235,658,000, are 7.8 per cent above the $2,073,009,000 volume for the 43-week period a year ago.

Public construction is 20 per cent lower than a week ago, but 48 per cent higher than the 1937 week, while private awards are 11 and 63 per cent lower, respectively, than last week and last year.

In the classified construction groups, industrial buildings are at the highest weekly level since May 19, 1938, due to a $4,000,000 strip mill project in Indiana. In addition, bridges and unclassified construction report gains over the preceding week. Gains over last year are in waterworks, sewerage, public buildings, earthwork and drainage, streets and roads, and unclassified.

New capital for construction purposes for the week totals $60,718,000, an increase of 766 per cent over the 1937 week. This volume is made up of $29,615,000 in USHA loans to municipalities, $23,545,000 in state and municipal bonds, $4,009,000 in REA loans, $2,699,000 in PWA allotments for non-federal projects, and $850,000 in corporate security issues.

New financing for the 43 weeks of 1938 totals $3,352,450,000, an increase of 62 per cent over the volume reported for the corresponding period a year ago.



CONTRACTS

(Thousands of dollars)

	Week Ending Oct. 28 1937	Oct. 20 1938	Oct. 27 1938
Federal	$4,640	$10,712	$5,282
State & Municipal	22,476	39,491	34,946
Total public	$27,116	$50,203	$40,228
Total private	35,750	15,021	13,406
TOTALS	$62,866	$65,224	$53,634
Cumulative 1938 (43 weeks)			$2,235,658
1937 (43 weeks)			$2,073,009

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1937 43 Wk.	1938 43 Wk.
NON-FEDERAL	$1,327,299	$2,208,805
Corporate securities	489,196	335,581
State & Mun. bonds	430,038	513,976
PWA loans, grants	178,126	767,189
RFC loans	29,939	100,128
U.S.H.A. loans	.....	232,422
R.E.A. loans	.....	58,009
Federal Aid-highways	200,000	201,500
FEDERAL	$746,223	$1,143,645
TOTAL CAPITAL	$2,073,522	$3,352,450

FHA MORTGAGES

	Oct. 21 1937	Oct. 15 1938	Oct. 22 1938
Selected for appraisal	$10,907	$21,117	$24,400*
Cumulative 1938 (42 weeks)			$819,198
1937 (42 weeks)			$503,814

* Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	Oct.	234.30	112.63
Building Cost	Oct.	195.48	105.67
Volume	Sept.	213	93

Professional Society Asks Higher Training

National Society of Professional Engineers would raise requirements of schools

Engineering education and student guidance and selection were the major subjects of discussion at business sessions of the fourth annual meeting of the National Society of Professional Engineers held in Pittsburgh, Oct. 17–19.

Action on these subjects was put in the form of resolutions. The first states that although the society believes that engineering schools are turning out more engineering graduates than the profession can absorb it does not ask that any arbitrary limit be set on students. It does, however, advocate quality selection and superior preparation and urges progressive raising of admission qualifications.

The second resolution "deplores and repudiates alluring and misleading propaganda heretofore placed before prospective students by agencies interested in promoting and stimulating increased enrollment in engineering schools" and states that the society "shall henceforth sponsor, and make available to prospective students, disinterested guidance information presenting an objective picture of what is in store for the prospective engineering graduate, as recorded by those working in the profession and not as rosily painted by those who are sheltered from the economic struggle."

A third resolution reviews the difficulties involved in imparting an adequate knowledge of engineering to the usual high-school graduate in four years and calls for at least two years of pre-engineering training as a prerequisite to admission to an engineering school.

Public works

Other resolutions adopted by the society include one requesting the Works Progress Administration to establish definite standards of engineering requirements for its various categories of work to be performed, to insist upon compliance with these standards, to adopt and enforce fair salaries commensurate with these standards and to require that all engineers in responsible charge of work in states having a registration law be registered professional engineers.

New officers elected are Perry T. Ford, Pittsburgh, president; John C. Riedel, New York, J. W. Beretta, San Antonio, W. C. Bickford, Seattle, and Sultan G. Cohen, Indianapolis, vice presidents.

Storm Damage Survey In New York State

September hurricane data on shore and river valley damage is assembled by Army Engineers

Reports by Corps of Engineers field parties to the district engineer in New York City give the first complete picture of damage done by the Sept. 21 hurricane along the Long Island coast and in the upstate river valleys.

Storm phenomena

The storm struck the New York coast about 2:30 p.m. on Sept. 21. According to U.S. Weather Bureau reports, the barometer, at 29.6 previous to the storm, took a sudden drop to 28.72 in. at 2:43 p.m. on that day. The storm moved in a northwesterly direction and all evidence places the center of the cyclone disturbance, as it entered the state, near Fire Island Inlet on Long Island. Inasmuch as the storm revolved in a counterclockwise direction and at the same time moved forward at a rate of about 40 m.p.h., maximum wind velocities were produced east of Fire Island and lesser velocities west of this point. For example, sustained wind velocity in Central Park, New York City, 60 ft. above the ground, was measured at 60 m.p.h. (with gust velocities 30 per cent higher), while the Weather Bureau estimates that a 100-m.p.h. ground velocity occurred at Westhampton; measurements on high buildings in New York City, however, approached this latter velocity.

Highest rainfall on Long Island was at Garden City,—11.9 in. for the week of Sept. 18–23, including 3.56 in. on Sept. 21 and 3.31 in. on Sept. 22. Tides averaged from 4 to 10 ft. above the normal heights; one point was as much as 15. ft. above at the western end of Long Island Sound.

Shore conditions

Tides, higher than predicted and earlier than expected, occurred both on the coast and in Long Island Sound. For example, at Sandy Hook, high tide occurred at 3:45 p.m. two hours before and 2½ ft. higher than the prediction. At 8 p.m., 5½ hours after the storm struck the coast, a storm wave occurred in Long Island Sound proceeding westward. At Throgs Neck, junction of the East River and Long Island Sound, it rose to 15.5 ft. above mean low water, against a previous record of 11 ft. Other figures are given in the accompanying table.

No great damage was done to structures such as jetties, groins, seawalls, piers, bulkheads, and bridges except for structures located on or near the south shore beaches on Long Island from Fire Island to Montauk Point. In general, all other waterfront structures weathered the storm remarkably well except for parts of timber superstructures easily ripped apart.

Before the storm the south shore of Long Island was protected by sand dunes 10 to 30 ft. high. The storm leveled off these dunes for 90 per cent of the distance between Fire Island and Montauk. In this stretch the barrier beaches were severed by ten new inlets, three of which are large; one is 300 ft. wide and 18½ ft. deep, forming an opening into Shinnecock Bay.

River floods

New York rivers, being west of the direct path of the hurricane, were much less affected than the Connecticut and Merrimack Rivers farther east. Nevertheless, on some of the smaller tributaries, 1936 discharges were exceeded. So far as actual losses were concerned, highway damage accounted for the greatest proportion. Railroad losses were also severe. A breakdown of the direct flood damages in the New York Engineer District by watersheds is as follows:

Hudson (New York)	$752,000
Mohawk (New York)	1,301,000
Hoosic (Mass.)	2,415,000
Otter Creek (Vermont)	400,000
Winooski (Vermont)	241,000
Total	$5,109,000

The Hoosic River watershed suffered more than any other in the New York district. At Adams, Mass., a new record stage was reached 2 ft. above 1936. The direct flood loss was about $450,000. In North Adams the loss was about $2,000,000 direct and indirect, as a result of inundation of 500 acres in the heart of the city.

In the Hudson watershed the village of Waterford, N. Y., was the heaviest sufferer on the main river. The peak stage of 31 ft. was 7.4 ft. above zero damage level and 2.7 ft. below 1936. The combined flow of the Mohawk and Hudson below Waterford was 150,000 sec.-ft. or 71 per cent of 1936 discharge. It is estimated that the Sacandaga reservoir lowered Hudson River levels 1½ ft. between Waterford and Albany. Monetary damage to Waterford was about $90,000, of which $20,000 is estimated as indirect.

On the Mohawk, main western tributary of the Hudson, sub-tributary discharges were nearly synchronized so that the main river went 12 to 14 ft. above normal levels. Considerable scour occurred on the tributaries, with silting on the main stream. Flood stages were reduced by Gilboa Dam on Schoharie Creek, Hinckley reservoir on West Canada Creek and Delta reservoir on the Mohawk, all of which were at low stage when the storm hit.

The New York state barge canal suffered damage amounting to $350,000, including $100,000 that will be required for redredging. The flood crested at 10 to 11 ft. above normal elevation. Embankment and spoil areas were badly scoured and all locks and movable dams hurt by debris. At Lock Ten, 100,000 cu.yd. of earth scoured from behind the lock, and the wingwalls were partly destroyed, while at Lock Twelve, about 50,000 cu.yd. of material was carried away, causing partial loss of the navigation pool. There were heavy silt deposits in the channel.

The main stem of the Winooski River caused only slight damage. The storm was somewhat more intense than in 1936, but the reservoirs built by the CCC above Barre, Montpelier and Waterbury maintained a high degree of control in these localities. On the Huntington and Mad rivers, uncontrolled tributaries, much damage was inflicted.

TIDES IN THE NEW YORK AREA

Station	Actual high Ft.	Time	Pred. high Ft.	Time	Previous record high Ft.	Date
Sandy Hook	5.9	3:45 p.m.	3.3	5:38 p.m.		
Fort Hamilton	6.5	4	3.3	5:45	6.4	11/10/32
Battery	6.5	4:30	3.1	6:20	6.2	11/10/32
Mill Rock	9.2	8	3.6	8:20	7.4	11/17/35
Willets Point	12.0	8	4.7	9:36	8.4	11/10/32

All of the above figures are elevations above mean sea level. The first two stations represent coast conditions; the next two East River, and the last Long Island Sound.

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Building Committee Named To Study Work Relief

In view of the probability that the next Congress will consider establishment of a permanent home and work relief program, the New York Building Congress has appointed a committee to study the work relief situation as it affects the construction industry, to make recommendations for a permanent program, and to report to the Building Congress.

Chairman of the Building Congress committee is J. P. H. Perry, Turner Construction Co. Other members are John J. Brennan, Building and Construction Trades Council; Ford H. Dow, The Dow Service; LeRoy Hagan, Jandous Electrical Equipment Corp.; Daniel P. Higgins, Eggers and Higgins; Julian C. Levi; Carlton S. Proctor; F. E. Schmitt, editor, *Engineering News-Record;* George T. Seabury, Am. Soc. C. E.; Roberts B. Thomas; and Albert A. Volk.

Palmer Discusses Construction Labor

Problems arising from organization on heavy construction considered at New York meeting

Labor relations constitute the most exacting problem of present day construction, and its solution will require the utmost in tolerance and trustworthiness on the part of employer and employee alike, said Edward P. Palmer, New York contractor and president of the Associated General Contractors of America, in an address before the New York Metropolitan Section, American Society of Civil Engineers on Oct. 19. A large audience heard Mr. Palmer outline labor conditions, existing and hoped for, in both the building and the highway and heavy construction field.

In the building field the tendency has been to form a new craft union for each new building material introduced, and some 20 new craft unions have come into the field during the past two decades. Also, and largely as a result of these new craft unions, jurisdictional disputes have tended to increase, while in the past few years satisfactory methods of arbitration have largely disappeared. In Mr. Palmer's opinion, employers are powerless to correct this condition.

Most of the address was devoted to the more recent development of unionization in the highway and heavy construction fields. That such unionization has not made greater progress is due in part to contractor opposition which, according to a survey made by Mr. Palmer, is based upon the following fears: (1) that jurisdictional disputes will develop, which would be ruinous to such a short-season activity as highway construction; (2) that the increased costs that might result would have a tendency to cut down construction volume, working to the detriment of employer and employee alike; (3) that labor has not demonstrated that it can or will keep agreements; and (4) that there is great uncertainty as to the fairness of the National Labor Relations Board.

Mr. Palmer pointed out that jurisdictional disputes in the building field are quite different from what they would be in such a type of construction as road building, where one job might pass through several different labor regions. Contractors have already experienced the difficulty on bridge building of having to make agreements with one labor group on one side of the river and another labor group on the other. Mr. Palmer called attention to the regional labor agreements made by A. G. C. Chapters in Oregon, northern California and most recently in the 33 western counties of Pennsylvania.

In discussion, W. J. Barney appealed to engineers to consider labor relations as much their problem as it is the contractor's. This is particularly necessary in specification writing where an engineer, unfamiliar with labor control over different building products, may so write specifications as to create jurisdictional disputes. Mr. Barney gave an example of a very effective specification which resulted from the engineer conferring both with the contractor and labor leaders, thus avoiding all difficulties after the job was under way.

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Professional Is Defined Under Wage-Hour Law

A definition of a professional employee was issued Oct. 10 by Elmer F. Andrews, administrator of the federal fair labor standards act. Professional workers, as defined by the administrator, are exempt from the wage and hour requirements of the act, which went into effect Oct. 24.

A professional, as defined by Andrews, is any employee who is customarily employed in work which is (1) predominantly intellectual and varied in character as opposed to routine mental or physical work, and (2) requires the consistent exercise of discretion and judgment both as to the manner and time of performance as opposed to work subject to active direction and supervision, and (3) is of such a character that the output produced or result accomplished cannot be standardized in relation to a given period of time, and (4) is based upon educational training in a specially organized body of knowledge as distinguished from either general academic education or from an apprenticeship or training in the performance of routine mental or physical processes in accordance with a previously indicated or standardized formula.

Union expresses opinion

The executive council of the Federation of Architects, Engineers, Chemists and Technicians, CIO, announced Oct. 25 its belief that "technical employees" are not bona fide professionals under the meaning of the act and are therefore subject to the wages and hours provisions. Organizational Director Marcel Scherer said that he had conferred with Commissioner Andrews and is "confident that his interpretation guarantees engineering employees the protection of the wage and hour law." All locals of the FAECT have been told to approach employers for payment of time and half for work over 44 hours.

LABOR NOTES

AFTER being held up for a week by a strike of common laborers, work was resumed on the new city hall at Houston on Oct. 24. City officials agreed to pay the cost of an increase from 40 to 50 cents an hour demanded by the laborers. The city made this offer early in the strike, but the proposal was vetoed by Regional Director Gus Street, Jr., of PWA, who said that he would not approve the change order. Work was resumed after the matter was referred to the Washington office of PWA under an agreement by which the higher rate will be paid from municipal sources, dating from Sept. 14, unless Washington objects.

WORK on the Wyandotte Country dam near Kansas City, now being reconstructed by WPA after the slide of September, 1937, has been halted by a strike of shovel and tractor operators seeking union recognition from WPA.

APPOINTMENT of a Milwaukee man as inspector of construction on a school building project in Racine, Wis., resulted in the Racine Trades and Labor Council threatening to call out construction workers if he is not dismissed and a local man appointed.

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O'Neil Dies in Dallas Was Sanitary Engineer

MATTHEW G. O'NEIL, 72, civil and mechanical engineer of Dallas who specialized in the design and construction of waterworks and sewerage systems, died there Oct. 22.

WILLIAM J. HENNING, supervising engineer in the department of water, gas and electricity of the Borough of Queens, New York City, died at Schroon Lake, N. Y., Oct. 24 at the age of 57. Henning had been with the department for about 30 years.

CHRIS STICHNATH, who retired some time ago from the position as assistant city engineer of Cincinnati which he had held for a quarter of a century, died recently in Cincinnati at the age of 72.

HENRY W. MCCALL, civil engineer in the Toronto city works department and formerly resident engineer of the northern division of the Grand Trunk Ry., died recently in Toronto.

GEORGE H. CHRISTIAN, 84, a retired civil engineer of Norwalk, Ohio, died there Oct. 19.

Construction Men Discuss Prospects of Industry

Means for stimulating more normal construction discussed at Washington conference of construction industry called by Chamber of Commerce

Construction industry prospects and means for maintaining a high annual volume of work were discussed in Washington, Oct. 20–21, at a conference arranged jointly by the Construction and Civic Development Department of the U. S. Chamber of Commerce and the Construction League of the United States. About 150 representatives of the many organizations concerned with construction were present.

A. P. Greensfelder, Fruin-Colnon Contracting Co., St. Louis, chairman of the construction committee of the U. S. Chamber of Commerce, in opening the conference reviewed the many fields in which construction has fallen behind normal requirements and outlined what is being done by his committee to help revive building work. This includes modernizing building codes and zoning laws.

Promotion needed

"The time has come for construction to generate some motive power of its own," said Thomas S. Holden, F. W. Dodge Corp., New York, "Until quite recently it has expected outside forces to create a demand for its products." Mr. Holden expressed skepticism as to current predictions of a demand for from 750,000 to 1,000,000 of family units a year. Housing, he said, will never attain large volume by reason of predictions but by improvements in methods of house production and in selling and financing methods.

Turning to other fields, Mr. Holden noted the passing of some of the worst phases of the controversy that has stalled the normal expansion plans of the electric utilities. Electric utility construction has averaged only $610,000,000 a year since 1930 as compared with $1,384,000,000 between 1925 and 1929.

Indirectly taking exception to statements made by Mr. O'Leary of the Chamber of Commerce in opening the meeting as to the urgency for reduction in taxation, Mr. Holden said that while the construction industry should not advocate any relaxation of vigilance on taxes, unsound spending and unsound public financing, it should do all in its power to educate the public as to the necessity for sound needed improvements and as to their essentially productive character. Public improvement programs, he said, have not been extraordinary as to total volume but unusual in the extent of federal financing. Complete cessation of federal financing appears unlikely, but we can hardly look for a greatly enlarged program until better financing has been developed and taxpayers are more prosperous.

Internal problems of the construction industry were discussed by Wm. S. Parker, Boston, general chairman of the Construction League, who said that such matters as wages, jurisdictional disputes and costs demand intensive consideration if we are to improve the efficiency of the construction industry.

Public works

Turning to a discussion of construction as a stabilizing factor, Mr. Parker pointed out that while private construction is primarily controlled by general economic conditions, public construction to a substantial degree can be used to correct depressions in the national income.

Any basic policy for public construction, said Mr. Parker, must recognize that while federal expenditures for construction can be expanded quickly to meet an emergency no such thing is possible with municipal expenditures, which make up about half of all public work. To give municipalities freedom to expand their expenditures in time of emergency, Mr. Parker proposed setting up a system of protected reserves which could be called upon at such times.

House construction

Wilson Compton, National Lumber Manufacturers Association, took strong exception to the current belief that all families with annual incomes less than $2,000 must look to a public agency for housing. He pointed out that if this is correct then 75 per cent of the proper housing of American people is beyond the scope of private building enterprise. Mr. Compton says that this is not so. However, he pointed out that the increases in national income which have come since 1934 have been largely absorbed by the income group below $3,000. This, he said, means that two-thirds of the market to which the building industry catered in the 1920's has disappeared. Under these new conditions about half the families of the country are not safe prospects for houses costing over $3,000. Consequently the Small Homes Demonstrations for 1939, sponsored by a large group of builders, distributors and manufacturers, will be concentrated on houses with a base cost of $2,500 or $3,000 including land.

Russell G. Creviston, Crane Co., Chicago, told of how leading manufacturers are actively developing applications of their products to house building on a production basis and are promoting new house construction as an aid to business recovery.

Construction costs

L. H. Olson, American Appraisal Co., New York, gave an informing talk on construction costs and values, drawing special attention to the effect of social policies in such costs. As an example, he cited workman's compensation as amounting to 11.7 per cent of building labor costs in 1938. This amounts to 4 1/3 per cent of building cost for that year.

Costs, said Mr. Olson, are not a major factor in determining whether or not the public will venture into new construction; the controlling factor is reasonable return on the investment.

Government housing

Government housing operations were reviewed by John M. Mowbray, Baltimore, who said that most of the work done to date did not meet the requirements of the low-income group needing government aid, but resulted in providing subsidized housing for those in a higher income group who could buy or rent their own homes. This sort of competition, he said, makes it impossible for private operators to rehabilitate housing that could be made serviceable by modernization. Mr. Mowbray made a plea for the establishment of "neighborhood reconstruction corporations" having a public utility status which under approval of local planning authorities could undertake the rehabilitation of whole sections of blighted areas.

Financing of small industries or branch operations was discussed by G. H. Porter, Baltimore. Mr. Porter favors the establishment of local real estate investment trusts not unlike the railroad equipment trusts that could put up standardized buildings for rent to new companies or for branch plants. This he said will help to overcome the opposition of manufacturers to tying up capital in a new plant.

Concluding sessions of the conference were given over to round table discussions of problems of the construction industry. At one of these representatives of labor organizations exchanged views unofficially with representatives of builders. The outcome was a request to the Chamber of Commerce to call another unformal discussion in the near future.

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

Fitting a Parabola To Grade Tangents

Sir: In the article entitled "Fitting a Parabola to Grade Tangents" by Lawrence N. Herb (Aug. 18, 1938, p. 215), the author seems to limit his discussion and illustration to one particular condition, namely: that the horizontal axis X–X of the parabola is the datum line of elevations; and that the distances x are to be taken along such horizontal line X–X.

This, of course, is not generally correct, since the datum line of elevations is not necessarily the horizontal axis X–X of the parabola, but may be a line lying altogether outside of the parabola and forming an angle with its horizontal axis. Also, the distances x may not necessarily be required along a horizontal axis but along either of the two grade tangents (according to the stationing usually given along such grade tangents).

The following material (prepared by this writer some years ago under the given caption) will be found, upon comparison with the article in question, more general and, hence, more correct:

In the illustration, the Figs. 1 and 2 show an upward and downward parabolic curve respectively. Referring to Fig. 1 (for the upward curve), the origin of the parabola is at P. C. and the distances x are taken along the right-hand tangent, the equation for the parabola being in the form:

$$y = \frac{Gx^2}{H^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Using the notation as in the figures, G and H (the constants in equ. 1) are determined from the following relation:

For Fig 1: $G = E\cos\theta = (F - D)\cos\theta = F\cos\theta - (C - A\tan\theta)\cos\theta = F\cos\theta - C\cos\theta + A\sin\theta$

For Fig. 2: $G = E\cos\theta = (D - F)\cos\theta = (C + A\tan\theta)\cos\theta - F\cos\theta = C\cos\theta + A\sin\theta - F\cos\theta$

$$H \text{ (for both figures)} = \frac{A}{\cos\theta} - G\tan\theta$$

(Note: The lengths of tangents T_1 and T_2 are readily obtained from the relation: $T_1 = H - G\tan\theta_1$ *and* $T_2 = G/\cos\theta_1$).

The general equation (for an upward parabola, as in fig. 1), giving the elevation at any point of the curve, is thus:

$$B + y\cos\theta = C - xs_1 + \frac{Gx^2}{H^2}\cos\theta \ldots (2)$$

Similarly (for a downward parabola, as in fig. 2), the general equation for the elevation at any point on the curve is:

$$B - y\cos\theta = C + xs_1 - \frac{Gx^2}{H^2}\cos\theta \ldots (3)$$

The slope of a tangent to the parabola at any point is (by differentiating equation 1):

$$\frac{dy}{dx} = \frac{2Gx}{H^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

In addition to the above, by differentiating equation 2 or 3 with respect to x and equating the derivative to zero, the *lowest* or *highest* point of elevation on the parabola (which are oftentimes required to be known in construction) are thus determined:

For Fig. 1: $\dfrac{d(B + y\cos\theta)}{dx} =$

$-s_1 + \dfrac{2x\,G\cos\theta}{H^2} = 0$ Hence $\times = \dfrac{H^2 s_1}{2G\cos\theta}$,

and the *lowest* elevation on parabola is:

$$C - \frac{H^2 s_1^2}{2G\cos\theta} + \frac{H^2 s_1^2}{4G\cos\theta} = C - \frac{H^2 s_1^2}{4G\cos\theta} \ldots (5)$$

Similarly, *for fig. 2*, the *highest* elevation on parabola is: $C + \dfrac{H^2 s_1^2}{4G\cos\theta} \ldots\ldots (6)$

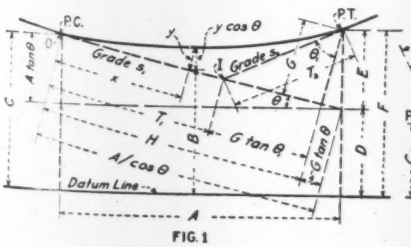


FIG. 1

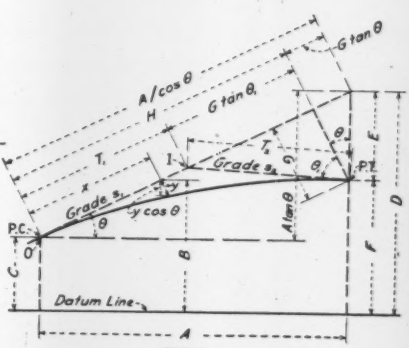
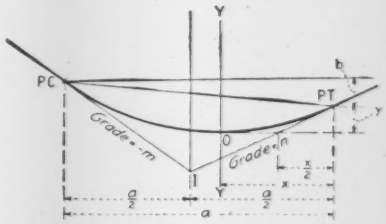


FIG. 2

DONALD BREGMAN
Chicago, Ill., Sept. 2, 1398

Sir: I am taking the liberty of commenting on an article in the "Field and Office" section of the issue of Aug. 18, p. 215, entitled "Fitting a Parabola to Grade Tangents." In the problem as stated we have given two grades "–m" and "n," the distance "a" between the points P.C. and P.T., and "b" the difference in their elevations. This is one factor more than the nature of the problem permits since "b" necessarily is equal to $\frac{a}{2}(m - n)$.



Finding the location and elevation of the low point of the curve by simultaneous quadratic equations seems unnecessarily cumbersome. Since the gradient of the parabola changes uniformly and is zero at the low point the location of this point can be found by direct proportion, that is, $x = a\left(\frac{n}{m+n}\right)$ or, $a - x = a\left(\frac{m}{m+n}\right)$ The elevation of the low point may readily be found by taking advantage of the fact that the tangent from this point will intersect the tangent from the P.T. at a point $\frac{x}{2}$ from the P.T. The elevation of this intersection will of course be the same as the elevation of the low point. The difference between this elevation and the elevation of the P.T. is equal to $y = n\frac{x}{2}$

THOMAS C. COLEMAN
West Somerville, Mass., Aug. 22, 1938

Errata

After the form containing "Alloy Steels in Sewage Disposal Plants", page 524, had gone to press, the following mistakes were found:

Page 526, col. 1, 3 lines from bottom, and col. 2, third line, "reheater" should read "preheater". Same col., line 22, "0.25" should read "0.20". Col. 3, 15 lines from bottom, "1.8 to 0.9" should read "10.8 to 1.8" and next to last line, change "gravity" to "pneumatic".

ENGINEERING NEWS-RECORD

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OCTOBER 27, 1938

PUBLIC RELATIONS, about which much has been said in these pages recently, begin at home, which is another way of saying that labor relations mark the first step in a public relations program. And in solving his labor problems the contractor needs the active aid of the engineer. Indeed, as conditions have developed, the contractor's labor relations have become a prime responsibility of the engineer. In specification writing particularly, this responsibility is manifest. Consider the situation in the building construction field, where the installation of each material is the assigned task of a different craft union. A specification writer who ignores this condition or is ignorant of it can easily—in fact will inevitably—produce a document that will guarantee labor difficulties. The jurisdictional strike, it has often been said, is one type of labor dispute over which the contractor has no control, either to avert or settle. Yet the engineer is in a position to do much toward making such strikes impossible by wise specification drafting. Joshua L. Barney, in emphasizing the close relation between engineering specifications and labor disputes at last week's meeting of the New York section, Am. Soc. C. E., urged engineers to add to their present knowledge of design and materials a consciousness of labor problems. The urging should not go unheeded. Engineers can perhaps serve their clients better by averting losses from strikes than by squeezing the last ounce of economy from their designs.

Enlarging the Heavens

SO MUCH PUBLICITY, justifiable to be sure, has been accorded the 200-in. glass casting for the reflector of the Mt. Palomar telescope that the equally amazing accomplishment of providing a mounting for the 500 tons of rotating parts has not been appreciated. The discussion of the mounting in this issue should help make up for this deficiency. Recently acquired ability to analyze indeterminate structures, the newly-developed art of welding, the results of modern research in lubricating oils, heavy manufacturing machinery, large capacity transportation and erection facilities, all have played a part in developing the huge mechanism and giving it the split-second precision that astronomers require. The layman is prone to think of bridges and buildings as the only product of the structural engineer. It is gratifying, therefore, and worthy of note when the structural engineer just as successfully meets unusual demands for a special structure. Whether it is a huge steel framed sphere for the New York World's Fair, a slender spire for a radio radiator or a telescope for enlarging the heavens, the structural engineer carries out these special assignments in outstanding fashion.

Corrosion-Resistant Metals

ONE OF THE LESS spectacular but nevertheless important developments in sewage disposal practice is the growing use of corrosion-resistant metals in the fabrication of equipment and structural elements. Unusually severe service requirements in treatment plants and increasing mechanization of processes has focused the attention of designing engineers on the properties and characteristics of special metals and alloys and their application to the special conditions encountered. New knowledge on this subject now comes from experience at the Chicago Sanitary District in the use of stainless and stainless-clad steel. As described this week (p. 524), alloy steels have been used successfully to combat corrosion and abrasion troubles in sludge processing equipment. This information, supplementing other data pointing to the use of wrought iron, aluminum, alloyed brass and bronze and monel metal in various parts of sewage treatment plants, indicates the progress that is being made in building more durable structures. All of this reflects itself in lower maintenance and replacement costs—factors of considerable importance in successful plant operation.

Construction Unaffected

CONSTRUCTION is not affected by the federal fair labor standards act which goes into effect this week. The act applies to the production and handling of all products (except agricultural) that move in interstate commerce. It applies to the manufacture of materials and equipment used in construction but not to construction operations. For example, most of the operations of a steel manufacturer come under the provisions of the act, but those of a contractor engaged by the steel company to build a new plant or in renovating an old one are not included. Whether construction work done by the steel company's own forces will be included ultimately is not known, but the present policy of those charged with administration of the act leans toward exclusion of such activities. These considerations apply to conditions as they stand today. Judging by past experience, construction is likely to be included ultimately along with all other in-

dustry, either by amendments to or court interpretations of this act or by state enactment and administration of similar wage-hour statutes.

Create a Demand

THE TIME HAS COME for the construction industry to generate some motive power of its own, said Thomas S. Holden at the Construction Industries Conference in Washington last week. Until recently, Mr. Holden added, the industry has expected outside forces to create a demand for its products. Mr. Holden thus turned the attention of the conference to the new thinking as to the construction industry's problems that is developing from the analysis of major industrial problems now spreading over the country. His statement is in line with those contained in the public relations program for the construction industry presented in our issue of Oct. 6. Industry generally is awakening to the fact that it must demonstrate to the public that the nation prospers only as industry prospers—that the nation in fact is industry. This is particularly true of the construction industry, the nation's second in size. But while other industries have publicized their activities the construction industry has sat back waiting for the public to call for its services. Likewise it has made no effort to foster simplification of the financing of new construction. Tardily, the unsoundness of this attitude is being recognized. The new call is for all elements of the construction industry to work together in stimulating a demand for the many new facilities that the nation needs.

Construction After Five Years

CURRENT REPORTS carry a piece of news that claims the attention of those who do not follow the day's statistical figures. The reports show that throughout the year new construction has been consistently strong, running ahead of 1937 in the face of calamitous decline in other fields of activity. Additional gains in recent weeks bring 1938 to a point nearly 10 per cent ahead of its predecessor. This fact is significant.

The drop in general business a year ago is described by those who follow economic records as the sharpest recession ever known. Construction did not share in this drop, however; except for a temporary dip it continued undisturbed, and since January it has forged ahead continuously. Evidently the conditions responsible for business losses and renewed unemployment in other fields did not influence construction, but the latter moved ahead under the impulse of independent motive forces.

Today's condition presents a striking contrast with the course of events five years ago, when the economic tide turned upward from the bottom of the great depression. At that time consumer goods led in the rise, while capital investment through construction was slow to increase. Even the strong rise that came in 1936-37 left construction lagging badly, with a resulting heavy burden of unemployment in building and construction trades. The recovery was one-sided, and before the middle of 1937 it broke down. It is not easy to rebuild prosperity and put idle men to work unless idle capital goes to work at the same time.

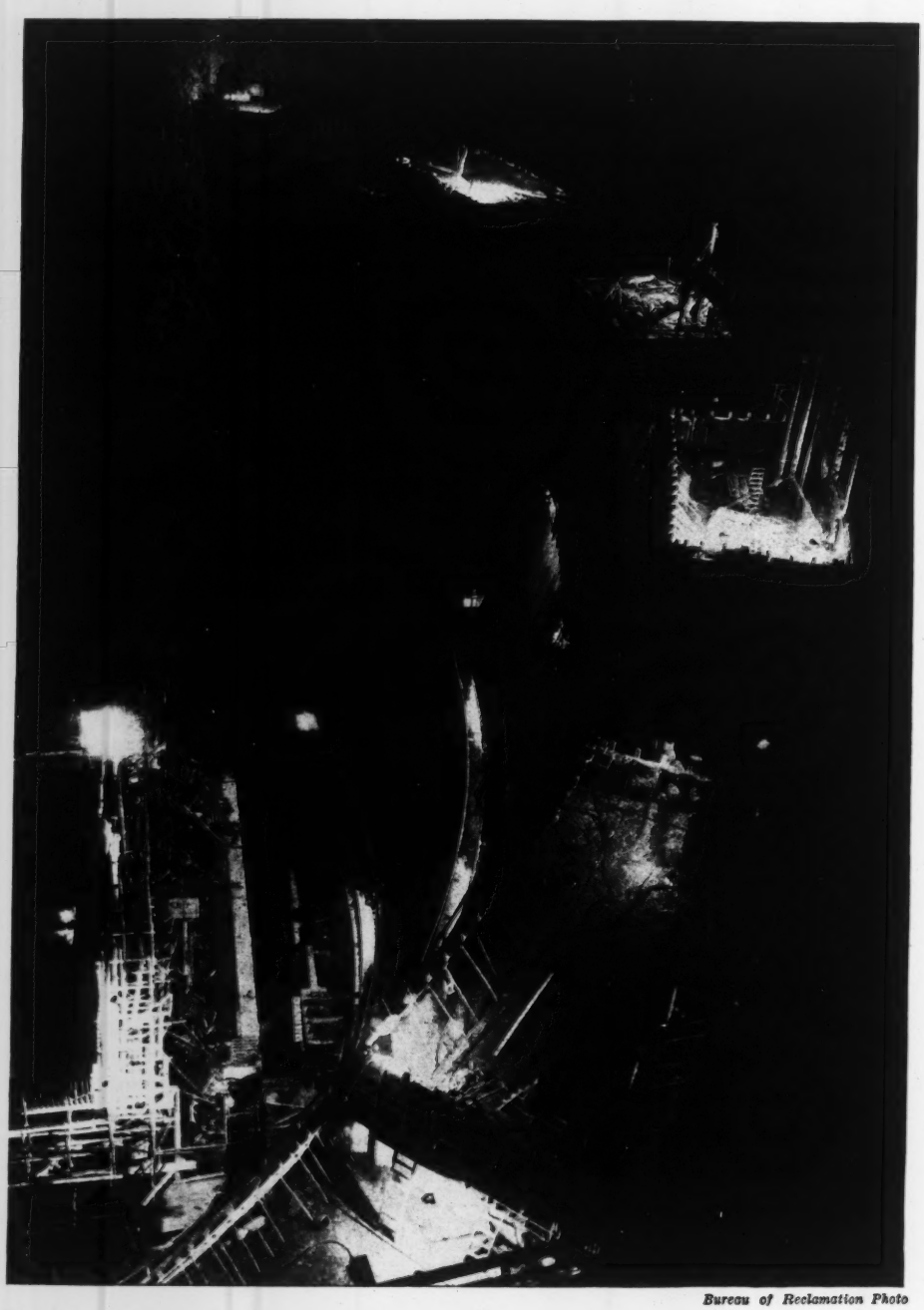
Had construction started up five years ago in pace with the revival of consumer goods production, the sequel might have been different. For, after all, this country's economic system is built on continued growth and progress, not on a subsistence economy. In normal times every fifth or sixth man of our population is occupied in creating new capital in the form of facilities for production or for the service of human convenience, and when most of these men are compelled to remain unproductive the industrial machine cannot resume normal functioning.

The present revival of industry begins under more favorable auspices than that of five years ago. We now have construction and capital investment in the lead of recovery, as was the case in recovery from earlier depressions—notably both 1873 and 1893. As other industry rises out of the past year's depression, therefore, we should have a more balanced growth and a more stable foundation. The outstanding fact that capital is being put to work at a substantial rate gives assurance that men will be put to work and that men and capital together will produce increased income and wealth.

With respect to the longer outlook some questions remain. The record shows that much of construction is still lagging badly. Housebuilding is at less than half the replacement rate; factory building is far back from its 1937 volume; utility construction remains cautious, and commercial building is only beginning. The resumption of local public-works activities likewise has not progressed far. In the meantime much of the present construction activity arises from the use of public emergency funds, and these are not likely to remain effective for long.

It is therefore a major question for the future how quickly private capital and local improvement investment will take the place of emergency spending. If they soon resume their normal place they will assure a degree of industrial activity and employment matching—perhaps exceeding—those of the best years in our past history.

PICTURES IN THE NEWS



Bureau of Reclamation Photo

ON SEMINOE DAM, in Wyoming, the newly-poured 54x24-ft. block in the foreground brought the dam to within 35 ft. of the top. Concreting will be completed this month. The powerhouse superstructure at the left is beginning to take shape, and should be ready for roof steel at the time the last mass concrete is placed.

Structural Aid for the Astronomer

Designing a steel mounting for the 200-in. reflecting telescope presented many new problems in supporting heavy loads that must rotate with great precision

A NEW AID in exploring the far places of the sky is being erected in Southern California in the form of a 200-in. reflecting telescope which is expected to advance the science of astronomy in three ways: (1) it is to push back the astronomical horizon so that the space volume whose contents can be studied will be about eight times as large as at present: (2) its unprecedented light-gathering power will permit making large-scale spectra that will increase our knowledge of distant atmospheres, and (3) it is to make available much new information about the unfamiliar members of our solar system. The planning and construction of the new instrument is an unprecedented undertaking in the matter of size and weight of elements involved as well as in the accuracy of workmanship necessary. Correspondingly, the requirements which the structural engineer has had to meet in designing and building a light but rigid telescope mounting involving such weights and such dimensions has transcended anything of the sort heretofore undertaken.

The original suggestion for the 200-in. reflector came from the late George E. Hale, director emeritus of the Mount Wilson observatory of the Carnegie Institute. The undertaking was made possible by the Rockefeller Foundation, which provided the necessary funds, estimated at about $6,000,000. Work was started in 1928 under supervision of the faculty of California Institute of Technology, Pasadena, Calif., and the installation in the observatory on Mount Palomar is expected to be completed ready for use in 1940.

Requirements for the mounting

The problem placed before the structural engineer in designing a suitable mounting for an instrument such as the 200-in. reflector was based on fundamental requirements laid down by the astronomers. These resolved themselves, in their essentials, into much the same need for two axes that has to be met in supporting the telescope of the engineer's transit. However, there are certain modifications arising from astronomical needs. The tube of the 200-in. telescope carries the optical parts but it is unlike the transit tube in that it requires the observer to be stationed at the forward end; the 200-in. mirror is at the rear end.

The mounting easiest to build would be designed like that of the transit; a simple frame carrying two axes of rotation normal to one another. Objections to this mounting were that, unlike the transit, the tube carrying the heavy 200-in. reflector must be rotated, perhaps about both axes simultaneously, *during* progress of observations. This rotation must be very smooth and very accurately controlled and in some cases the relative rates of rotation about the two axes must vary in a complicated manner. The axis in the telescope mounting parallel with the axis of the earth is referred to as the polar axis; the other axis is the declination axis.

If a mounting similar to that of the transit were used its bottom plate would have to be inclined to the horizontal by an angle equal to the latitude of the observatory. At Mount Palomar this angle is 33 deg., 21 min., 20 sec. Thus, to permit observation toward the south, the bottom plate would have to be notched to permit necessary rotation around the declination axis. In lieu of a notched

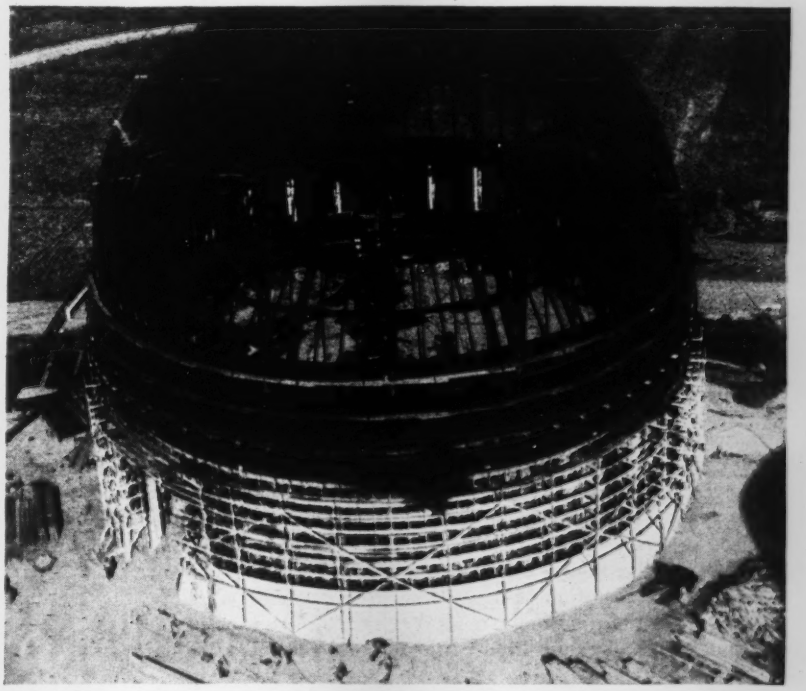


Fig. 1. Frame of steel dome on Mount Palomar under construction.

Fig. 2. A working model on a one-tenth scale (a 20-in. reflecting telescope) now in operation at Pasadena illustrates the mounting to be used. The pair of tubes make up the yoke.

plate a simpler design was sought to avoid complex stresses in carrying the heavy loads.

After extended study a yoke-type mounting was chosen in which the arms of the yoke are extended far enough to clear the lower end of telescope tube. There they meet in a common support which constitutes the lower polar bearing. Another type considered as an alternate carried the load on arms that acted as cantilevers, whereas in the yoke type the arms act as simple beams. With the yoke design any irregularities in the lower polar bearing are halved at the declination axis; in the cantilever type such errors would be doubled. Finally, the yoke has about twice the rigidity of the cantilevers and the elastic deformations are more uniform for different position of the reflector.

At first the plan was to build the yoke much like a pair of inclined highway bridge trusses connected by a third truss bridging the closed lower end. If this were done, diagonal bracing could be used across the portals and between the end posts. Later this plan was revised to substitute for each of the inclined trusses a steel tube 10½ ft. in diameter and 1 in. thick. These tubes are 35 ft. apart on centers; they are connected at the south bearing by a box girder and at the north end by a horseshoe support, which also has a box-girder cross-section. These tubes should not be confused with the telescope "tube," which is an open lattice framework rather than a closed tube.

Reference to the one-tenth scale model of the mounting, Fig. 2, will aid in understanding the arrangement of supports. The axis of rotation of the yoke is inclined upward to the north at the angle of latitude, and a horseshoe-shaped support (seen at the rear) carries the raised or north end of the yoke. Thus the north bearing for the polar axis is located at the bottom of the horseshoe, which rotates with the yoke.

This horseshoe support, which in the large telescopes, will be 46 ft. in outside diameter, constitutes one of the most interesting elements in the mounting design. Under the loads which it carries in operating the 500-ton weight of the rotating parts, in the position of maximum stress, the cantilever stresses on the upper end of the horseshoe tend to make the two horns close about ⅛ in. To compensate for this movement the outer periphery of the horseshoe will be machined with a strut spreading its mid section and a tie drawing the outer ends of the horns toward one another; strut and tie will be so placed that when released there will be additional material on the periphery at the outer ends. This material will raise the horseshoe on its bearings sufficiently to compensate for the deflections. The correction will not be perfect, but it will be within the astronomical requirements. The walls of the member to be machined have a thickness of 4½ in., of which less than ½ in. will be removed in the machinery.

Essentially the yoke consists of two 10½-ft. tubes or steel girders spaced 35 ft. apart, tied together at the lower (south) end by a crossbeam. Within these tubes will be fitted-up spaces for observers using spectographs and other equipment. The crossbeam will carry the south bearing, and at the north end the load will be carried by the rigid horseshoe-shaped box girder of circular periphery already mentioned. This horseshoe will permit the reflector tube to be pointed toward the north at an angle low enough to observe the pole star and its neighbors.

Structurally, the important features of the yoke are the north and south bearings of the polar axis, which carry a rotating load of 500 tons. The periphery of the horseshoe is supported on two equalized pairs of oil pads spaced at an angle of 60 deg. The oil pads, 28 in. square, are machined to the same radius as that of the outer periphery of the horseshoe, from which they are separated by a thin film of oil supplied continuously under a pressure of 250 lb. per sq. in. from orifices in the surfaces of the pads. This thin film (0.003 in. thick) separates

the two metal surfaces and, in effect, floats the heavy load on oil.

The south bearing is, in principle, a ball-and-socket joint which can carry both radial and thrust loads. The "ball" is a hemisphere 84 in. in diameter attached to the lower end of the yoke. The socket is composed of three circular pads 37 in. in diameter, machined concave to fit.

As in the case of the north bearing, oil under high pressure reaches the space between the two spherical surfaces of the south bearing through orifices in the stationary parts, thus establishing an oil film that gives the mounting a smooth, easy movement. Such movement is essential to the very slow rotation of the telescope, normally 1 revolution per day.

The reflector tube

The so-called reflector tube is not a tube at all but rather a steel lattice or frame for supporting the 200-in. reflector and facilitating its rotation about the declination axis. The reflector tube is 55 ft. 4 in. long by 22 ft. in diameter, and the weight of the complete "tube" assembly that rotates about this axis is 125 tons. Instead of having the usual octagonal cross-section, the central portion of this tube where the trunnions are carried consists of a hollow cube built of structural steel. The eight corners of the cube are connected by A-frame triangles of steel struts to eight points (four above and four below) on circular rings at the ends of the tube. These rings support the 200-in. mirror at the inner end of the tube and at the outer end a cage containing optical equipment and an observers' station.

Fig. 4 shows a simplified diagram of this frame or tube, which constitutes the structural support for most of the optical parts. This tube has a rectangular cross-section and four faces similar to the face *axbx*. The bottom ring, within which is nested the 200-in. mirror, is fastened at four points, one in each face, as "*a*." The top ring, which supports the observer's house and auxiliary mirrors, is similarly fastened at four points as "*b*." When the tube is turned from the vertical to the horizontal the weights "*P*" and "*Q*" cause top and bottom rings to be deflected downward. With support as shown, points "*a*" and "*b*" deflect parallel with "*XX*."

Fig. 3. Structural frame for the telescope tube assembled in the shop. Note rectangular central section with bearings for declination axis and elastic hinge joints at the corners of the rectangle.

By adjusting the area of the diagonals "*ax*" and "*bx*," points "*a*" and "*b*" can be made to deflect the same amount. The diagonals in faces at right angles act as spacers, so that the bottom and top rings remain parallel. Then, since points "*a*" and "*b*" deflect the same amount, there is no relative motion between the top and bottom rings. It was not possible to bring the center of gravity of the loads precisely to the intersections "*a*" and "*b*," but undesirable deflections were kept within allowable limits.

The four faces of the rectangular section in the telescope tube are connected by elastic hinge joints designed to give very little resistance to bending but great resistance to stretching. In these joints the metal-to-metal connection is reduced, as nearly as may be, to a single line, represented by one row of bolts (see Fig. 3). This does much toward simplifying calculations and removing the uncertainty of indeterminate stresses.

It was thought necessary to provide a universal joint or gimbal between the tube and the declination bearing spindles in order to prevent overloading of the bearings and to avoid transmitting possible deflections to the tube. The amount of movement this gimbal has to permit will be very small, hence it was possible to design it without bearings but permitting movement by virtue of elastic deflections, in short, a form of elastic hinge joint. The gimbal consists of a rim and spokes in which the spokes are arranged opposite to the space plan used in a bicycle wheel. That is, all the spokes radiate from a single point in the hub to two circles on the rim spaced about 2 ft. apart. This arrangement is very rigid for axial and radial forces but permits slight angular movement. The

principle is illustrated in Fig. No. 5.

Practical solution of the problems in design of the reflector tube mounting included those involved with varying weights of and convenient positions for the observers who "ride the tube," which they do for the first time in this unprecedented instrument. It was necessary that observers be made comfortable for prolonged observations, that chairs and working platforms remain horizontal while the tube turns in its hour angle, and that ready access and exit be provided as well as absolute control over all possible movements of the mounting.

The mirror and its balanced support

The 200-in. disk was cast at Corning, N. Y., in 1935. About a year was required to anneal the disk before it was removed from its mold and shipped to Pasadena, where the grinding and polishing job was begun in May 1936. It is hoped that this process will be completed in 1940 and that the various auxiliary mirrors also will be ready at that time so that the telescope can be put into service without further delay.

The reverse side of the disk is ribbed like a waffle, except that the ribbing is composed of equilateral triangles whose sides are 30 in. long. Although the glass casting is about 24 in. deep at the edges, the glass between ribs is nowhere more than 5 in. thick. At each of the 36 vertices of triangles in the "waffle" back there is a cylindrical boss containing a cylindrical depression to receive the mirror's supporting mechanism.

The 16-ton weight of the glass casting is carried by 36 compensators which fit tightly into depressions at the vertices of the triangles. These compensators consist essentially of a system of levers and counterweights, arranged so that they give a vertically upward reaction to the glass equal to exactly one thirty-sixth of the weight of the glass regardless of the position of the telescope, and regardless of the deflection of the steel table which supports the compensators. By this method the mounting avoids bending stresses in the glass casting which might interfere with true reflection of the images being observed.

Design of the hemispherical dome for housing the telescope was the subject of special investigation. Although there is ample literature on the buckling of cylinders very little could be found on external load for a hemispherical dome, especially one without rib supports, as was planned in early stages of this study. Accordingly, tests were made on a 36-in. model using spun copper plates, 0.02 in. thick. The intent was to see what load such a model would carry before it failed by buckling.

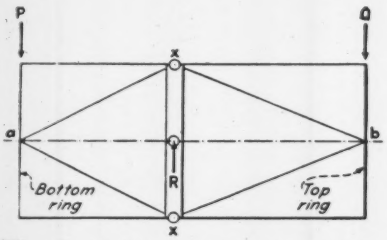


Fig. 4. Skeleton outline of members designed to keep deflections parallel in opposite ends of the frame carrying the reflector.

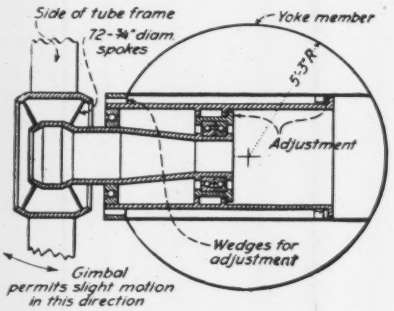


Fig. 5. Section through one of the pair of gimbal bearings that transit reflector tube loads to the declination axis.

Fig. 6. Shop assembly of one of three segments in the horseshoe of the north polar bearing at the Westinghouse Philadelphia shop. The large plate is 4½ x 60 in. x 47 ft.

The tests were made by constructing a concrete bowl of hemispherical shape and of a diameter slightly larger than that of the model. The model was inverted, placed in the concrete bowl, and by means of stud bolts projecting upward from the edges of the bowl was held rigidly in position against any thrust tending to float it out of the bowl. While it was held in this position mercury was poured into the space between the model and the concrete until the desired loadings were obtained.

A model without a slot and a model in which a slot corresponding to the 30-ft. slot in the full-sized dome were tested. In the tests with the slot a strip of wood and a rubber gasket were used to close the slot so that the mercury could not enter the inverted dome. The slot was found not to be a factor in the strength of the dome against load thus applied.

Buckling of the model dome under the mercury loading occurred at about one-fifth the theoretical load. However, the final test on the model consisted of a mercury loading together with concentrated loads, which showed the factor of safety against buckling, with all possible loads on the structure, to be more than two.

(As a result of these model tests there has been some discussion among structural engineers of the curious and unexplained disagreement between theory and practice in the strength of domes. Also, of the corresponding discrepancy in thin cylinders, which likewise have been found to buckle at about 20 per cent of the theoretical load.)

Erection of the dome for housing the 200-in. telescope was practically finished in 1937, although much still remains to be done in connection with the installation of the telescope. The building consists of a rotating part and a stationary part. The top of the latter part forms the observing floor from which the instrument will be operated. Below are offices, laboratories, and storage space.

The outer structure has at its base a circular wall 30 ft. high surmounted by a circular track welded in place and then ground true. On this track roll the 32 four-wheeled trucks which carry the rotating dome. The dome consists of a hemisphere 137 ft. in diameter resting on top of

the circular wall of the structure.

The exterior surface of the dome is ⅜-in. steel plate. An inside framework was erected first to hold the plates in place during the welding process and afterward to act as stiffeners to prevent buckling. On each side of the shutter opening is a box-section arch 3 ft. wide by 8 ft. deep, and near the bottom of the cylinder is a horizontal ring girder whose function is to keep the cylinder circular. The entire structure was arc-welded. Bolts were used only as required during the erection prior to the welding.

The telescope will be supported on a base frame carried on four separate concrete piers. Every effort was made to isolate the base frame and its foundation from the remainder of the structure.

In the manufacture of the large structural steel parts for the telescope mounting, welding is being used extensively. However, the welding is all done in the shop, where subsequent annealing is possible; no welding will be done in the field, and instead the field connections are heavily bolted joints. The annealing furnace is 26 ft. square and 20 ft. high; in its operation the requirements are that a slow heat be applied until a temperature of 1,150 deg. F. is reached, after which the oven is allowed to cool and the annealing heat is applied a second time. Some large pieces were used in the assembly: for example, the north bearing yoke is made up of three sections in each of which there is one steel member 4½x60 in. x 47 ft.

Astronomical work is under way on Mount Palomar pending completion of the big reflector. The 18-in. Schmidt telescope has been in operation there since 1936; with it Dr. Fritz Zwicky last fall discovered two super-novae or exploding stars, a forerunner of the contributions to knowledge about the universe expected from the 200-in. reflecting telescope.

Spotlighting the Low-Cost Road

Montana Bituminous Conference indicates a rapidly developing technique in the use of local soils

THE LOW-COST ROAD is the problem of every state highway department. It is the primary problem of the mountain and plains states west of the Mississippi River and of all the coastal states of the South. With long distances, thin populations and scant funds these states must have inexpensive roads and yet good roads. Traffic demands no less in speed of travel and all year service in these wider open spaces than it does in the states of the East where cities and industries rub shoulders. This is why the Montana Bituminous Road Conference, started in 1935 by Montana and a few neighbor states, has grown until two weeks ago at Biloxi, Miss., it was attended by over 250 working delegates from 39 states, Canada and the Argentine. The registration was over 500.

Theoretically the Montana conference embraces all types of bituminous roads but factually its work is limited to low-cost types. Its distinction and the value of its work lies in this fact. Of the 50 individual reports presented at the Biloxi conference, all were on low-cost bituminous roads. Half a hundred reports indicate ordinarily an overcrowded program but this error is avoided by the organization of the conference. Its work is divided into four sections: research, fundamentals, construction and maintenance. Each section is headed by a chairman and a conference board, generally of twelve members, selected to represent as wide a range of roadbuilding conditions, practices and requirements as is practicable. Each conference member reports to the chairman on a selected phase of his general subject. The chairman epitomizes these reports and presents a concise summary to the meeting after which he and his committee sit as a conference board to answer questions and explain details that are not understood.

This explanation of the conference organization is given to indicate how so formidable a program as fifty technical papers, and many of them long papers, are handled adequately and fairly in four half-day sessions.

Research comes first

The chairman of the research section this year was Norman W. McLeod, research engineer, Saskatchewan Department of Highways, and his conference board included thirteen laboratory and materials engineers from the highway departments of eleven states. There were therefore thirteen reports from which to select the kernels of useful information. Perhaps not wholly to the satisfaction of the asphalt technologists, the attention centered on soils research.

Reviewing progress in soil mechanics as related to the design and construction of bituminous surfaces, Prof. W. S. Housel (Michigan) pointed to advance in the plastic and liquid limit tests for evaluating the waterholding and binding capacity of soils and to the development by these tests of criteria for evaluating volumetric changes in soils with changes in moisture content. In the matter of frost-action, which is so vital to road upkeep, Professor Housel referred to the interesting research work leading to the constant-frost-line theory of Taber and the fluctuating-frost-line theory of Benkleman and Olmstead. Both sets of investigations agree in indicating that soils of silt texture should be removed from the subgrade to the lower limit of the frost line. Taber does not agree, but Benkleman and Olmstead demonstrate conditions under which even the coarse-textured sands and gravels may cause frost heaving and that indicate the possible necessity for lowering the water table below the frost line even in these soils.

Among new conclusions from current research, Professor Housel instances recent tests at the University of Michigan that indicate that the bearing capacity of granular soils does not depend on internal friction

but on arching action or actual support of adjacent particles in a granular mass. Also among recent developments is Vohac's demonstration that the effect of both the rate of loading and the dimensions of the specimen must be evaluated in making compression tests of bituminous mixtures.

Soil classification

Beginning about the time that the Bureau of Public Roads was developing its familiar numerical classification of soils, the engineers of the Michigan road laboratory began study of a different system, that of the U. S. Bureau of Chemistry and Soils, generally used by soil scientists. Technically this is known as the pedological system and is told about in the text books; briefly, it is a classification that identifies soils by separating them into zoned groups, series, types and phases. To the general reader this is not very elucidating but the subject is one for the soil specialist and not for engineers in general. Yet O. L. Stokstad (Michigan) reported that as developed in Michigan the highway field engineers become proficient in using the classification in a few months. For full understanding the reader must be referred to the complete report which is a long document. Both Housel and Stokstad expressed the conviction that in pedological classification as developed in Michigan supplemented by soil tests in specific cases the road engineer has a definitely time-saving aid in location and design.

Stabilization practice

Under the topic of soil stabilization reports were made by Hans F. Winterkorn (Missouri) and Prof. John S. Crandell (Illinois). Dr. Winterkorn discussed particularly the use of chemical admixtures. Soils experts are generally familiar with the doctor's abstruse studies in Missouri on the chemical character of soil particles, base exchange capacity and electrostatic character, and few others are; he is essentially a doctors' doctor. But to get down to the effect of the various salts now used in soil stabilization, Dr. Winterkorn summarizes them qualitatively as follows:

1. A changing of the surface chemical character of the soil particles by the absorption of ions from the salts. 2. Greater surface tension cohesion in the stabilized soil because of the increase in the surface tension of the water brought about by the presence of these salts. 3. Equalization of moisture content in the soil due to the deliquescent or moisture retaining properties of the salts. 4. A decrease in volume change upon drying due to crystallization of the salt. 5. Decrease in the swelling of the soil because of presence of the salts in the soil mixture. 6. Certain components of the stabilized soil may be more soluble in the salt solution than in water, leading to the possibility of redisposition of this material as cement.

Professor Crandell moved decidedly away from theory to test results and practice in his review of research results in stabilization as reported in recent technical literature. Readers of *Engineering News-Record* have had during the year most of the facts disclosed by Professor Crandell and they need not be repeated. A concluding quotation has interest as eptimozing the Professor's reaction: "There is considerable groping around in the dark and no one in a responsible position wishes to go on record as being able to produce certain and sure results."

Bituminous research

Turning to research in bituminous mixtures, R. L. Wales (Arkansas) reported observations (hardly research) on actual construction. Crushed stone and crushed gravel are used for open graded surfaces and bank and river gravel for dense graded construction. Individual materials have shown lack of asphalt bond but generally nothing fundamental in either adhesion or in absorption has been disclosed. Referring to primes, L. C. Krchma (Socony-Vacuum) reported that in general RC materials do not penetrate well because of too rapid evaporation or absorption of the solvent which results in a membrane type of prime. However, with highly absorptive materials such as scoria they may be the only materials that dry fast enough to give a good prime. Mr. Krchma thinks MC and SC materials are best for primes and MC is more generally satisfactory (1) because it sets up, leaving the asphalt well distributed and (2) it possesses greater adhesion to aggregate. Krchma also believes that MC materials having high gravity, high asphaltine and positive spot characteristics are superior because of their greater adhesiveness to negative spot materials. Concluding, Krchma indicates preference in use for the mat or wearing course of MC or SC materials for dense-graded road mixes; MC for dense graded plant mixes, and RC for open-graded mixes. For mats, Bailey Tremper (Washington) also agrees that MC materials are preferable to SC materials although there are some notable exceptions.

Because of the hardening of bituminous materials in service, Prevost Hubbard (Asphalt Institute) recommends engineers (1) as far as is practicably possible to use a soft asphalt, (2) to use as high a percentage of asphalt, (3) to mix and lay mixes at as low a temperature and in as short a time, (4) to compact and seal thoroughly. Other facts on mixes brought out by Krchma, Tremper and Hubbard are: Formulas for bitumen content are being abandoned for laboratory determinations and the judgment of the engineer in the field. Hot mixes are still proportioned on the basis of voids and cold mixes by surface area.

Two reports by Winterkorn (Missouri) and Kemper and Erwin (Washington) ranged over the highly interesting problem of bitumen adhesion to aggregates. They each presented a study of the theoretical points involved.

Scholarly as the bitumen discussions were, the conclusion was excellently stated by Mr. McLeod who said: "From this review of the adhesion problem it is apparent that while much investigation has been done and is still being carried on, there does not exist a universally acceptable test method for evaluating the relative adhesion of mineral aggregates for bituminous materials and for water."

About the same can be said of the papers by W. M. Carney and F. R. Grant (Lion Oil), L. M. Law (consultant), and Prevost Hubbard on research developments in the service behavior of bituminous materials.

A liaison task follows

Drab as the probings of research appear in the telling they are the force that steadies and directs the

hand of the field worker in construction and maintenance. That is why the Montana conference stresses research and another coordinating activity, "fundamentals of construction", in its program. Defined, the fundamentals committee is the liaison body between those responsible for research and those responsible for actual construction and maintenance. This year the committee consisted of Thos. E. Stanton, Jr., materials and research engineer, California Division of Highways, and his conference board consisted of twelve engineers representing ten states and Canada. Discussion by the conference board somewhat roughly divides into subgrades and foundations, selection of bituminous materials and mixes.

Little change in thought appears in the discussion of general principles of soil analysis and subgrade construction; compaction at optimum moisture content is still the increasing practice. This is considered by J. O. Martineau (Quebec) and J. H. Swanberg (Minnesota) to emphasize the need of specialists for field and laboratory work. The interdependence of base, subbase and surface is stressed by Prof. W. J. Emmons (University of Michigan) and he states that Housel's theory of design of flexible surfaces has been substantiated by field tests by the Michigan state highway department. Martineau indicates that what is needed now is not more research but the actual application in construction of the knowledge already had. Referring to the California practice since 1929 of compaction at optimum moisture content, J. W. Stanton, Jr. (California) notes that some states have been inclined to classify on the basis of liquid limit plasticity index and shrinkage determination. Since these determinations are made on material finer than 40-mesh and the soil actually used in construction may contain a relatively small percentage of such fine particles, California prefers to make determinations on the material as it will be used, except that materials coarser than 1 in. are screened out.

In the selection of bituminous materials, the discussion indicated about the same trends as did the discussion on research. C. L. McKesson (California) says: "Soft asphalts have a longer useful life than hard asphalts and may be used without sacrificing stability." He also considers ductility to be the most important physical property of asphalt. J. W. Powers (Arizona) states that ductility tests as they are conducted are not satisfactory. He also presents evidence that hardening of asphalts is chiefly a surface phenomenon. J. H. Swanberg states that he is inclined to doubt Mr. McKesson's evidence that "the softening of an asphalt by a volatile, as in a cutback, will ultimately result in an asphalt of less ductility." In rebuttal, T. E. Stanton states that California experience is definite in showing that with standard MC grades at least there is undue tendency toward hardening and brittleness: for this reason the state is using medium curing cutback with SC-6 road oil as a base.

In respect to aggregates, J. W. Powers presents data on the swell test and concludes that: "If the swell test is to be used as a basis of acceptance of mineral aggregates the characteristics of the oil used will have to be specified." The results indicate, he states, that the service behavior of questionable aggregates may be modified by certain oils. T. E. Russell (Wyoming) also states that he has found that aggregates show a different swell with different grades of oil. J. W. Powers and T. E. Stanton suggest adopting a standard test oil: Mr. Stanton suggests an SC-4, which is suitable for either road or plant mix and in the laboratory for both swell and stripping tests.

Out of a discussion that swung back and forth in opinion there was general agreement that: 1. Better tests for consistency are needed: this property is now measured by penetration, float viscosity and the viscometer (all rather unsatisfactory). 2. There are no tests in general use that satisfactorily determine the resistance of an asphalt to displacement by water.

Construction practice

The construction section headed by V. B. Steinbaugh, chief engineer, Michigan State Highway Department, brought out a round dozen discussions by the conference board members representing as many states. Some of the discussions were confined to individual projects. Included for consideration here are papers by T. V. Fahnstock (North Carolina) and W. H. Mills, Jr. (South Carolina) which with discussion of practice in Alabama by Leon Gottlieb and in Florida by John R. Slade cover the sand-bituminous base and the surface treatment practice of the southern coastal states. Practice in these states has been described in recent articles in *Engineering News-Record* and it need not be repeated.

Mr. Slade states that in Florida the material powdered asphalt has been added to the materials that will be used in processing sand bases and that the use of traveling mixing plants will be allowed. G. S. Covert (Mississippi) describes a road in which after five years the asphalt had dropped from an original 45 to 24 Abson recovery, or a loss of 44 per cent. He attributes the consequent cracking to "drying out of the mix" rather than to "hardening of the asphalt." H. C. Groves (Yale Oil Corp.) describes a plant mix job in North Dakota in which the stabilized gravel base is 5 ft. wider than the surface mat to ensure firm shoulders. In mat construction all 2 to 5 deg. curves were widened 1 ft. on the inside and the thickness was increased. H. D. Mills (Nevada) states that now a separation of crushed stone aggregates into three sizes is demanded and the material passing the 10-sieve is limited to 45 per cent. J. D. Brown (Michigan) describes recent laboratory experiments that appear to demonstrate that a certain amount of moisture followed by a drying period before placing the mixture is required for effective distribution of the bitumen.

Reviewing present practice and trends in airport surfacing, W. R. Macatee (Asphalt Institute) summarizes trends as being toward: 1. Lighter, less-expensive types; 2. Utilizing local materials more extensively; 3. More extensive use of flexible types; 4. Thicker asphalt coverage of the aggregate; 5. Use of softer asphalts; 6. Asphalt stabilized bases; 7. Cut-off walls of asphalt mixtures at the ends and sides of runways.

Maintenance

Because it was the last session of a tired conference discussion of maintenance fell almost to zero. Some of the dozen discussions prepared but not presented will be reviewed in a future issue.

Alloy Steels in Sewage Disposal Plants

Stainless and stainless clad steels are used in Chicago plants where corrosion and abrasion troubles are encountered in sludge processing

One of the interesting features of the sludge handling equipment at the Calumet and Southwest sewage treatment works of the Sanitary District of Chicago is the extensive use of higher alloy steels. Previously, the use of stainless clad steel pipe was made in the extension of the Milwaukee sewage disposal plant where an 1,300-ft. length of air-pipe, most of it 60 in. in diameter, was installed. (ENR, Dec. 13, 1934, p. 759.) In 1935 these alloys were given a trial in Chicago on a limited scale in the construction of sludge-handling equipment at the Calumet works. In revamping the installation at this place the engineers used stainless clad steel for the surge-bin unloader trough and dry-sludge return conveyor. This stainless steel contained 18 per cent chrome and 8 per cent nickel which is ordinarily spoken of as 18-8 steel.

Based on the satisfactory performance of this installation, alloy steels were called for in the specifications for the sludge disposal equipment for the Southwest works, contracts for which were let in August, 1937, and construction of which is not yet completed. It is the use of alloy steels in this plant with which this article is principally concerned.

In both the Calumet and Southwest plants the activated sludge system of treatment is used, with the disposal of sludge by incineration. The Southwest works has eight sludge-handling units each consisting of filter-cake conveyors, sludge mixers, sludge distributors, conveyor scales, surge bins, surge bin unloaders and dry-sludge return conveyors. A single conveyor handles sludge fertilizer from all the units. Each conveyor, sludge distributor, sludge mixer and bin unloader is equipped with individual motor drive, including a speed reducer. Variable speed transmission is used on several of the drives. Each of the eight drying units involves a mill type dryer, two separators, circulating fan, induced-draft fan, vapor heater, drying towers, separator stacks and all necessary appurtenances for making a dust-and-vapor-tight system.

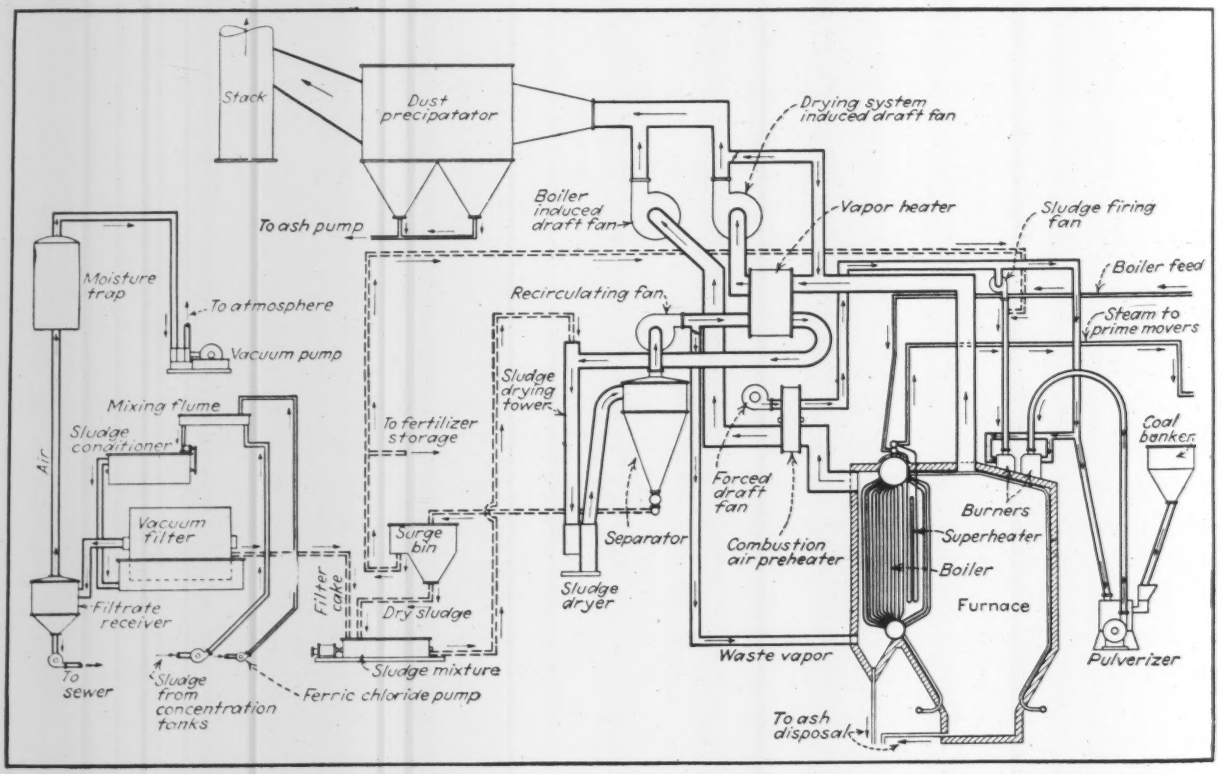


Fig. 1. Flow sheet of the sludge processing system at the Southwest sewage disposal plant of the Sanitary District of Chicago

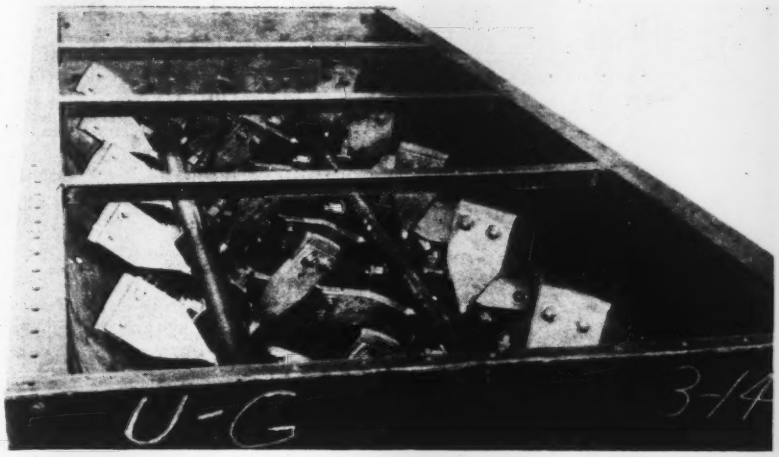


Fig. 2. **Paddles of the sludge mixer are tipped with chromium-tungsten-cobalt alloy and the sides are lined with removable plates of stainless steel.**

Sludge taken from the activated sludge tanks contains 98 to 99 per cent moisture. This material is pumped into concentration tanks where the moisture content is reduced to an average of 97 per cent. The sludge is then pumped to a dosing flume where it is mixed with a ferric chloride solution which serves as a coagulating agent. Coagulated sludge is dewatered by twenty-four large vacuum filters, each with 570 sq.ft. of filter surface.

Here the moisture content is reduced to 78-80 per cent, leaving the sludge in the form of a cake. This cake is scraped off and dropped onto 24-in. belt conveyors which move it 170 ft. to the sludge mixers. Enroute the sludge cake is weighed on conveyor scales. These are equipped with a totalizing mechanism with an accuracy of plus or minus 1 per cent when operating between 12 and 24 tons per hour.

Mixers get hard service

In the sludge mixers is found the first use of alloy steel. The mixers are U-shaped troughs, 15 ft. 8 in. long, 4 ft. 5½ in. wide at the top and 3 ft. 2 in. deep inside. The sludge is forced through the mixers by double-shafted twin-paddle conveyors. The 1,160-r.p.m. speed of the 15-hp. motors is reduced to 25 r.p.m. through herringbone reducers and roller chains. To avoid excessive wear the tips of the paddles are made of hard tool steel of chromium-tungsten-cobalt alloy.

Built of ⅜-in. steel plate, the mixers are lined throughout with 3/16-in. plates of solid 18-8 stainless steel. The primary purpose of going to this more costly lining material was to overcome three difficulties formerly experienced in similar installations: (1) The corrosive conditions set up by the combination of warm dried sludge and the cold filtered sludge cake which contains a small amount of ferric chloride. (Ordinary steel plate fails rapidly in this service); (2) excessive abrasion caused by the gritty nature of the sludge cake; and (3) the sticking of sludge to the bottom and sides of the mixers which occurs when ordinary steel is employed. When this occurs excessive

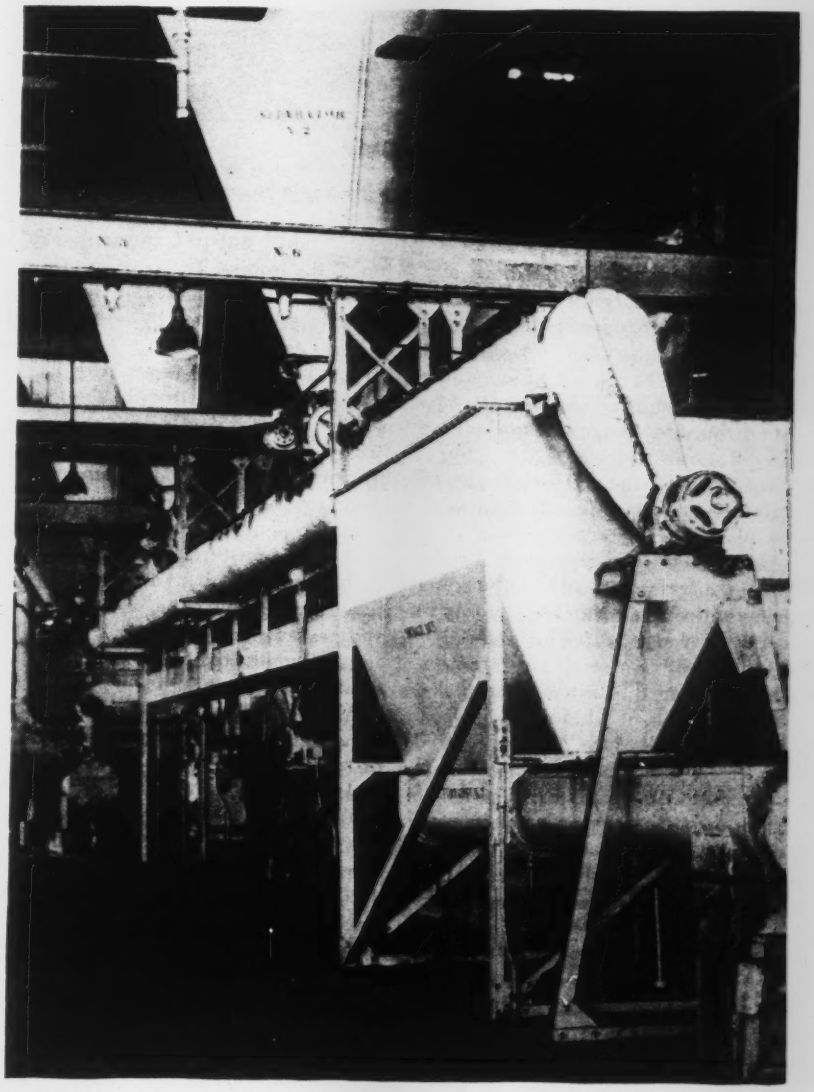


Fig. 3. **Sludge separators, conveyors and bins at the Calumet plant where uses for special steels were developed.**

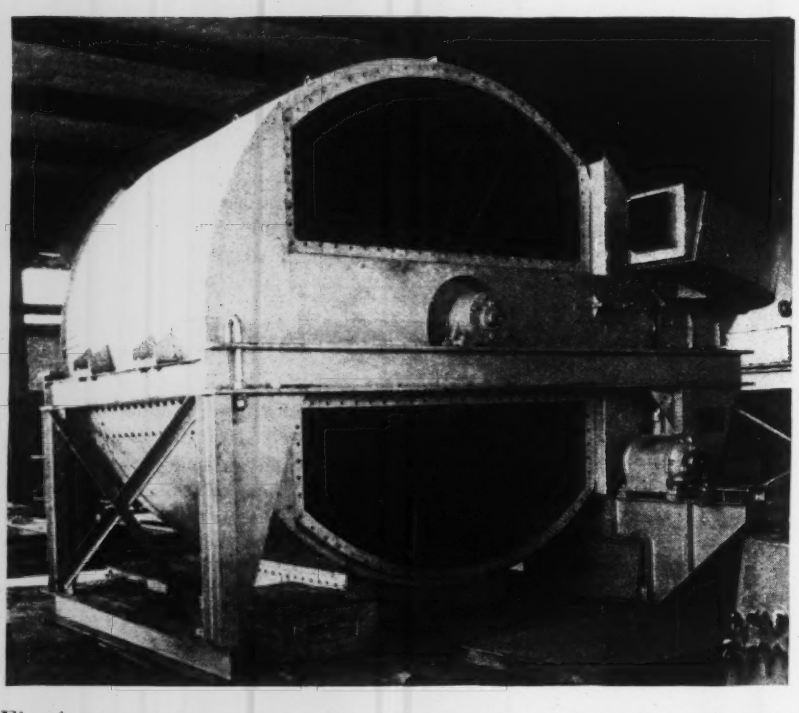


Fig. 4. Vapor heater in which rotating elements of heat resisting alloy steel extract heat from the flue gas channel and transfer it to the sludge drying vapor cycle.

power is required for the drive and the material often piles up to such an extent that the paddles (which have a clearance of only 1/16 in.) stall and are the source of considerable maintenance trouble and expense. It was found that the sludge did not adhere to 18-8 stainless steel.

In view of the extensive use of stainless clad steel in other parts of the plant, one may ask why a solid stainless steel liner was used for the sludge mixers instead of building them entirely of the less expensive stainless clad steel. The reason is that these mixers receive severe punishment from the gritty sludge cake, and regardless of what metal is used, the mixer walls have to be replaced sooner or later. Since the walls are well ribbed and reinforced, complete replacement is a major expense, compared to the replacement of liners.

High temperature protection

From each of the mixers the sludge of 40-50 per cent moisture content is dropped into a drying tower, 20 ft. high and 13 sq. ft. in rectangular cross-section. After passing through reheaters, hot gases composed largely of superheated steam or vapor at 1,100 deg. F. are introduced near the top of the towers. The temperature of the products of combustion from the furnaces as conducted to the reheaters is 1,400 deg. F. The sludge is dropped down through each tower to a flash-type dryer at the bottom of the tower where it is violently agitated and broken down. It is then conveyed in suspension in the vapor stream to large cyclone separators which deliver the sludge, now dried to a 10 per cent moisture content, to the sludge storage bins, or as they are called surge bins. The excess vapors and gases vented from the drying circuit are conducted to the furnaces for deodorizing.

All high-temperature duct connections to the reheaters were fabricated of 3/16-in. plate of the 23 chrome-12 nickel analysis, with carbon specified at 0.25 per cent maximum. Metal of this analysis was necessary to withstand the temperatures which reach 1,800 deg. Other high temperature ducts were made of 3/32-in. 18-8 steel. The vapor heaters on the high side used stainless steel of 18 chrome-, 8 nickel, 0.12 carbon, and titanium limited to four times the carbon. On the low side an alloy of 4-6 chromium-0.4 to 0.6 molybdenum and 0.10 carbon is employed.

The drying towers, constructed of ¼-in. steel plate, were lined with 3-in. insulating blocks. Over these blocks and forming the inner shell of the towers was placed a welded surface of 18-8 steel, containing titanium as a stabilizing element to retain maximum corrosion resistance after welding. This special steel withstands the 1,400-deg. F. maximum temperature in the drying towers.

Handling dry sludge

From the cyclones the dried sludge drops into surge bins. Starting at this point, stainless clad steel has been used extensively for the surge bins, surge-bin unloaders, fuel-bin unloaders, fertilizer conveyors, dry-sludge return conveyors and all chutes and gates used in conjunction with this part of the equipment for handling dried sludge.

The surge bins, 17 ft. long, 3 ft. $6\frac{3}{4}$ in. wide and 6 ft. $10\frac{3}{8}$ in. deep, are made throughout of 18-8 steel having a 20 per cent stainless cladding. Plates 3/16-in. thick are used for the surge bins, with proper support and stiffener members. These bins are equipped with division plates placed between the sludge compartment and the fuel compartment to prevent the dried sludge from falling directly onto the surge-bin unloader. Covers prevent the escape of dust, gases and solid particles. The surge bins, which are made relatively shallow so that the sludge will not pack down and be difficult to remove to the bin unloader, are filled only to a certain level above which the sludge falls onto a fuel-bin conveyor and is fed directly into the incinerator.

Unloaders under each of the surge bins are constructed of 3/16-in. stainless clad plate and are in the form of troughs in which the sludge is conveyed by means of twin helicoid screws having speeds varying from 1.8 to 0.9 r.p.m. The purpose of the adjustable speed is to permit the correct amount of dried sludge to be delivered through the dry-sludge return conveyor leading to the sludge mixer to insure an ultimate moisture content of 40-50 per cent in the sludge mixer.

Dried sludge of 10 per cent moisture content is fed from the surge-bin either to the dry-sludge return conveyor mentioned above, or to the fuel-bin unloader, which conveys the dried sludge to the fuel bin for gravity delivery to the incinerator. The por-

tion of sludge which is to be taken for fertilizer is bypassed from the fuel bin to a 180-ft. conveyor, by which the sludge is delivered outside the building to a truck-loading site.

The eight fuel-bin unloaders are similar to the surge-bin unloaders only smaller, having but one helicoid screw conveyor operating in a trough of 3/16-in. stainless clad steel. These are also variable speed conveyors, being driven by 2-hp. motors through motorized worm-gear and roller-chain reductions to give final speeds to the screw conveyors of $6\frac{2}{3}$ to 40 r.p.m., depending on the amount of material being delivered to the fuel bin.

The portion of the sludge which is burned is used to supply heat for drying the sludge. Pulverized coal is also burned in the same furnace to generate steam for driving turbines which generate power to operate the various conveyor drives, pumps and blowers in the treatment works.

Large use of special steel

Some $42\frac{1}{2}$ tons of stainless clad steel and 6 tons of solid stainless steel was used in the sludge-handling equipment and more than 30 tons of solid stainless steel was utilized in the sludge-drying equipment. In excess of 20 tons was used in the vapor heaters.

Since the Southwest plant has been under construction, the Sanitary District has replaced three steel units at the Calumet plant with stainless and stainless clad steel. These units consist of surge bins, hoppers, vapor seals and gravity sludge chutes. A further use of high-alloy metal has been in the construction of a large transformer oil storage tank where the stainless steel clad interior surface of the tank insures freedom from metallic impurities in the oil.

According to the engineers, the use of alloy steels has justified their cost when each alloy has been carefully selected to combat some specific condition. Solid heat-resisting alloys have been used where excessively high temperatures are encountered, regular 18-8 solid stainless steel where the combination of corrosion and excessive abrasion are to be overcome and the lower cost stainless clad steel where corrosion is the primary cause of failure.

Design of the sludge handling equipment in both the Calumet and Southwest plants was carried out under the direction of William A. Dundas, engineer of mechanical design of the Sanitary District of Chicago of which W. H. Trinkaus is chief engineer and H. P. Ramey, assistant chief engineer. Construction is being supervised by L. B. Barker, construction engineer. The sludge handling contracts are part of the work financed by loan and grant from the Public Works Administration under the direction of Joshua D'Esposito, resident projects engineer PWA.

The following suppliers furnished equipment mentioned in this article: sludge handling equipment (including fabrication of bins, conveyors, unloaders, mixers and drives, variable speed transmissions, speed reducers and flexible couplings, Link-Belt Co.; sludge drying equipment, Raymond Pulverizer Division, Combustion Engineering Co.; wet sludge filters, Oliver United Filter Co.; motors, General Electric Co. and Allis-Chalmers Manufacturing Company; conveyor scales, Merrick Scale Co.; stainless clad steel and stainless steel used in sludge-handling system, Ingersoll Steel & Disc Division of Borg-Warner Corp.; stainless steel used in sludge-drying equipment, Allegheny Steel Co.; preheaters, Air Preheater Corp.; drying tower insulating blocks, Johns-Manville Co.; alloy tips, mixer paddles, Haynes-Stellite Co.

A. S. C. E. Meets in Rochester

Fall meeting of American Society of Civil Engineers shows major interest in soil mechanics

SOIL MECHANICS as applied to foundations, dams and trench construction developed into the subject of most active interest at the fall meeting of the American Society of Civil Engineers at Rochester, Oct. 12-14, but the sessions of the waterways, structural, power, sanitary engineering and city planning divisions also were notable for sustained interest and discussion. Overlapping sessions of the power and soil mechanics divisions proved to be disappointing to a number of members interested in both subjects.

Flood control

Flood control was the center of interest in the waterways division meeting. Its highlight was the presentation of the flood problem of the Genesee River as it courses through the heart of Rochester, by Edwin A. Fisher, 91-yr. old city engineer emeritus and honorary member of the society. Most spectacular was Mr. Fisher's vigorous elaboration of his paper into a microphone broadcasting to the region with the aplomb of a young announcer.

In planning for the safe passage of flood flows through Rochester both Mr. Fisher and the late John R. Freeman concluded that provision must be made for a flood of 90,000 sec.-ft. in the Genesee River. This figure is two-thirds larger than the 1865 flood of 54,000 sec.-ft. The basis assumption used in arriving at the 90,000 figure was 90 per cent runoff of a 7.26-in. rainfall in 3 days when the ground might be frozen or saturated. The estimated storage in the watershed area when the peak flow is reached in the city is 14 billion cu.ft. distributed over a natural storage area (valley and lakes) of about 100 sq.mi.

Perfecto A. Covas, assistant engineer, joined Mr. Fisher in the preparation and presentation of the paper.

Henry L. Howe, city engineer, in discussion, indicated that upstream protection must be met by flood storage reservoirs to replace the natural storage now available in the farmlands but eventually to be cut off by dikes and retaining walls.

E. H. Sargent, chief engineer, Hudson River Regulating District, Albany, gave results of operating the Sacandaga Reservoir in regulating

the Hudson River. This is a multi-purpose reservoir, built 8 years ago and having a capacity of 760,000 acre-ft., equivalent to 13.7 in. of run-off of the contributory 1,040 sq.mi. watershed on which the annual average rainfall is 27.6 in. It is this large percentage capacity to which Mr. Sargent pointed as one of the principal factors in making possible the satisfactory multi-purpose use. By use of this reservoir it has been possible to raise the minimum flow in the Hudson from 350 sec.-ft. to above 2,300 sec.-ft.

No water passed over the spillway in March, 1936, although flood flows to the Hudson were kept down to 39,500 sec.-ft. whereas without the reservoir probably they would have reached 92,000 sec.-ft., the greatest in the river's recorded history.

Power companies pay for the use of the water but there are no restrictions on the board as to release of water. Only 3 ft. of storage immediately below the spillway crest is reserved for flood control in the spring. Mr. Sargent stated that absolute integrity is required on the part of the regulating authority to withstand any temptation to sacrifice flood storage for power purposes.

In discussion E. S. Cullings, chief engineer, Black River Regulating District, Watertown, confirmed Mr. Sargent's conclusions, also emphasizing the necessity of having a relatively large capacity with respect to the tributary drainage area. Three reservoirs in the district have a combined capacity of 128,000 acre-ft. Three more are necessary for 50 per cent control, Mr. Cullings estimated.

Clarence E. Boesch, principal engineer, North Atlantic Division U. S. Engineer Department, in discussing these papers indicated that the operator of a multi-purpose reservoir must be ready for the unexpected since nature is always "playing tricks" on schedules and charts of operation made from historical records. He referred to the unprecedented New England storms which came in the usually dry fall month.

Major George J. Nold, district engineer at Binghamton, outlined model tests for the southern New York flood control project. A model of the Chenango River through Binghamton was built at Cornell University and used to test out improvements suggested. Other tests on variations in the model of the Arkport Dam outlet were presented as discussion by Prof. E. W. Schoder, Cornell University.

Thousand Islands Bridge

The recently opened Thousand Islands Bridge over the St. Lawrence River not far from Rochester was the major subject for discussion at the structural division meeting. Also discussed at that meeting were structural features of the New York Central grade separation work at Syracuse, the principal paper being by Nelson F. Pitts, Syracuse.

William T. Field, Watertown, reviewed the history of the Thousand Islands Bridge Project, including some interesting accomplishments in international cooperation, and D. B. Steinman, New York, Chauncey M. Goodrich, Walkerville, Ont., and R. Boblow, New York, discussed structural details. This bridge was described in *ENR* August 25, p. 231.

Soil mechanics

The practical application of soil mechanics to building foundations and dams was discussed actively at two sessions, the subject being opened by a report on progress of the soil mechanics and foundations division given by Carlton S. Proctor, chairman of the executive committee of the division. Nine committees have been established in the two years since the division was organized. Reports are expected in the near future on the bearing value of pile foundations, prepared in collaboration with the waterways division, on terms and definitions in soil mechanics, and on the present status of the art of obtaining undisturbed soil samples. This latter report will be presented at the January meeting.

The history of soil mechanics was briefly reviewed by George L. Freeman, consulting engineer, New York, as a preface to his remarks on practical application of the science to substructure problems. Mr. Freeman also gave a quick summary of the characteristics of soils that give the foundation engineer his chief problems. Knowledge of soil mechanics is needed, Mr. Freeman said, when engineers plan to support a structure of any magnitude on a compressible soil when retaining walls, bulkheads or cofferdams are planned, or when earthfill dams or highways are under consideration. In making field investigations Mr. Freeman urged that "hillbilly" methods of making tests and interpreting them be discarded. Test loads, he said, should be 1½ or 2 times the ultimate loads to be imposed and should remain in place until there has been no settlement over a period of 2 hours. Boring should go far enough below footings or pile tips to reveal the presence of compressible soils. As to the pile driving, both soil bearing tests and pile load tests must be used with recognition of the fact that results obtained for single units do not necessarily reveal what larger areas or pile clusters will carry.

Mr. Freeman questioned the value of pile loads determined by the "hoary old *Engineering News* formula" or any other impact formula which makes no allowance for energy losses in the driving equipment and the pile itself.

It is highly desirable, said Mr. Freeman, that in different localities where compressible soils are found there should be collected and recorded foundation and performance data for typical structure so that engineers may have more complete understanding of the properties of local soils. These records, he said, must be obtained through the organized efforts of municipalities and engineering bodies.

Prof. G. P. Tschebotareff, Princeton, also had a bad word to say for indiscriminate use of pile-driving formulas in his observations concerning lessons to be learned from settlement studies of structures. Professor Teschebotareff illustrated his talk with many examples of bridge and building settlement, largely from Egypt, and pointed out that statically determinate structures stand a much better chance to survive serious settlement than do indeterminate structures. His studies show the unreliability of such practices as load tests of small units and the need for full scale settlement studies on structures for which settlement rates have been forecast from laboratory studies. Only by such checks can more accurate predictions be made for future structures in any region. He urged the local sections to promote such studies and cited the Philadelphia section as leading the way in this work.

Lazarus White, Spencer, White & Prentis, New York, added further support to the conclusions of previ-

ous speakers by showing striking examples of the effect of differential settlement of a church which had been built on compressible soil without adequate study of its characteristics.

Earth dam construction

Methods of soil control in the earth dams of Muskingum Conservancy District were reviewed by Robert J. Philippe, Pittsburgh, at the second session of the soil mechanics division. These included a modification of the method developed by R. R. Proctor. Experience showed that the amount of rolling has little effect as compared with change in the weight of the sheepsfoot roller, also that over-compaction is to be avoided if dangerous movements in the dam are to be avoided when it becomes saturated.

Serious movements that have taken place in Glendening and Tapper dams in the past two years have led to a careful restudy of what was done in building those structures and to certain conclusions as to errors made in design and construction. Over-compaction resulted in horizontal movements in Glendening dam even during construction. The core was built of fat clay which showed relatively large tendencies to deflect under load without failure. The foundation of similar clay did not possess sufficient rigidity to resist it but the restraint of the berm was sufficient to prevent appreciable deflection along contact of the foundations, thereby introducing a point of rigidity at the base of the core. The upstream shell was not thick enough to develop the shear required to resist deflection of the core with the result that when high water in the reservoir further reduced the shearing resistance the shell failed along the contact of the core with the foundation. When sufficient support had been removed the core fractured.

Joel D. Justin, in discussing Mr. Philippe's paper, pointed out that when the slope of the core is flat, as in Glendening dam, a larger part of the weight of the shell is carried by the core adding to the forces that must be restrained in the lower regions. Cores of inherently unstable material should be made as narrow as possible, he said. Like views were expressed by Glennon Gilboy in written discussion.

The recent slide at Fort Peck dam made necessary a last-minute elimination of the scheduled paper on the application of soil mechanics to that project. In its place, Charles Terzaghi, father of soil mechanics, put on a rapid fire review of progress in retaining wall design which left all but a few close students of the subject like Lazarus White trailing far behind. Coming down to practical application of theoretical studies, Dr. Terzaghi told of how the contractors for the Berlin subway had completely redesigned the cut bracing at considerable saving in cost as the result of his studies. Actual measurements of pressures confirmed his conclusion that maximum pressure is not at the bottom but at about mid point. Dr. Terzaghi concluded his talk by urging engineers to promote continuation of research into this subject, and in a facetious vein stated that the soils laboratory at M.I.T. is the best equipped laboratory to undertake the study.

To this Lazarus White made quick reply that he had the best laboratory, namely the subway cut under 6th Ave., New York, where for many months past he has been conducting careful studies of the subject. His test equipment and methods, he holds, are better than those used in Berlin.

Sanitation

The sanitary division in its one session, considered pollution problems in New York State and learned of methods employed in four sewage treatment plants in cities near Rochester.

A. F. Dappert, principal sanitary engineer, New York State Department of Health, and C. A. Holmquist, commissioner of sanitation, indicated that the state is well on the way toward a clean-up of its streams. No typhoid epidemics have occurred since the serious outbreak at Olean in 1928. Great advances have been made in abating pollution of small streams and surface supplies. In 10 years, three times the population previously served with treatment plants are now served.

In discussion, Prof. C. L. Walker, Cornell University, outlined the development of sewage treatment progress since the dilution project of the Sanitary District of Chicago was recommended by Rudolph Hering at the turn of the century. S. G. Hess, chief engineer, Interstate Sanitation Commission, described the work of his organization which was set up under a compact between New York, New Jersey and Connecticut calling for a clean-up of boundary waters. The commission has chosen not to use its legal powers but to cooperate with officials and to educate the average citizen largely through newspaper and other publicity.

Glenn D. Holmes, director-chief engineer, Onondaga County Sanitary Sewer and Public Works Commission, Syracuse, N. Y., described in detail the Grey Creek activated sludge sewage treatment plant which serves 20,000 people in a suburb north of Syracuse.

Similar descriptions were given by S. A. Greeley, consulting engineer, of the Buffalo plant, by Kenneth J. Knapp, sanitary engineer, of the Irondequoit plant for Rochester and by P. B. Streander, consulting engineer, for the Niagara Falls plant.

Traffic control

Urban traffic control was covered in the one session of the City Planning Division. Miller McClintock, director, Bureau for Street Traffic Research, Yale University, stated four causal factors of the engineering problem as follows: (1) Medial friction; (2) Marginal interference; (3) Intersection friction; (4) Internal stream friction. These are the factors to be met. He suggested his well-known "Limited Way" design as meeting all factors as it has no access to private property, no grade crossings and a rational segregation of different speeds.

E. G. Speyer, consulting engineer, Buffalo, outlined the Buffalo traffic problem which is aggravated by its street pattern of circles and diagonal streets like Washington. A survey provided information for setting a progressive stop-and-go signal system speeding Delaware Ave. traffic to 25 m.p.h. and 1,200 vehicles per hour per lane.

Traffic control now and in 1926 in Rochester were illustrated on the screen by Leon R. Brown, research engineer, Rochester Transit Corp. The Rochester Engineering Society has been continuously active in helping solve the problem. It began by getting movies taken of congestion back in the Model T days when, so

the pictures indicated, double parking, no signals, passing street cars on the left and no restricted curb parking seemed regular. The greatest progress that has been made Mr. Brown states, is in eliminating parking entirely during the day on important streets.

Burton W. Marsh, American Automobile Association, Washington, D. C., stressed the fact that 75 to 80 per cent of the traffic accidents involve pedestrians who are to blame for over 50 per cent. An engineering approach to the problem is needed, he stated. Engineers have failed to see the relation between the physical structure and the necessity of properly operating it so as to utilize it to the maximum.

In a paper by A. W. Brandt, state commissioner of highways, New York, read by George Miller, assistant highway engineer, location of super highways in the state was outlined, mainly on new right-of-way 250 ft. wide. Cost per mile of the 1,000 mi. proposed will average $300,000, he stated. Two 12-ft. lanes each way with a 20-ft. mall between is the usual section. Only minor things can be done to the existing 30,000 mi. two-lane roads such as lengthening curves, increasing sight distances, better signing and providing pedestrian walks.

Power plant economics

Factors affecting the economic position of water power plants held a leading place in the two sessions of the power division. A. T. Larned, Phoenix Engineering Corp., New York, stated that the unfortunate placing of a few hydro-electric plants has given water power a bad reputation which can only be restored by careful study of the place of such plants in existing systems, by sound forecasts of future power need, and by simplification of design to lower capital costs. Mr. Larned also drew attention to the fact that steam station designers are constantly working to cut their overhead costs, thus causing constant changes in comparative costs of steam and hydro. As examples, Mr. Larned cited the gradual elimination of housing around boilers and turbines.

Discussing Mr. Larned's paper, Prof. H. K. Barrows, Boston, stated that the cost of adding units to hydro plants generally costs less than adding to steam stations. He pointed out that the output of hydro stations can also be improved by additions to pondage. However, he cautioned against snap judgment in deciding to add upstream storage as a means for increasing output. Except under exceptional circumstances the cost per acre-foot for storage is too high to justify the expense involved.

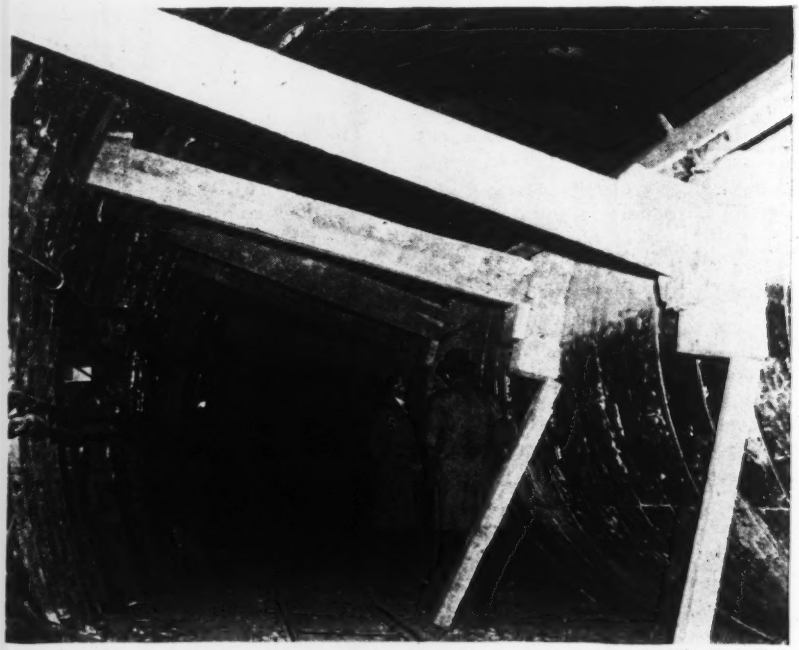
Phillip Sporn, in a written discussion, said that hydro plants must do better than meet steam costs as the capital investment in hydro plants is large and must be amortized over a long period of years while capital costs of steam stations are less per unit of output and planned to be written off in less time due to the rapidity with which steam stations become obsolete. He also said that hydro plants are not as advantageous from the viewpoint of national economy as are steam stations due to the larger employment created by the latter.

R. A. Monroe, TVA, Knoxville, in written discussion, went on record as opposing limited development of water power sites. All studies, he said, should include flood control, navigation and irrigation needs as well as power.

H. G. Gerdes, consulting engineer, Charleston, S. C., in a statistical paper which was presented in summary form in his absence, stated that he had attempted to set down cost data for the power plants of hydro-electric developments on a truly comparable basis, including all factors affecting the plant cost. Engineering, overhead, and interest during construction were not included. His studies, Mr. Gerdes said, showed that more money could profitably have been spent on engineering at many plants whose costs he had analyzed.

Data concerning hydraulic turbines and power houses needed by designers in their preliminary studies were given by W. L. Voorduin, TVA, Knoxville. The data were limited to medium and lowhead plants with either Francis type turbines or propeller-type runners having fixed or movable blades.

Developments in model testing for turbines was reviewed by L. M. Davis, Penn. Water & Power Co., Baltimore, Md.



Wide World Photo

SUBWAY WITHIN A SUBWAY

BECAUSE it was necessary to enlarge the tunnel on a section of the London subway system without interrupting traffic, a new tube was built around the old one. The old tube, through which trains are passing every few minutes, is seen above inside the new and larger tunnel.

FIG. 1. MATS READY TO APPLY PRESSURE ON NEW TOP FOR CONCRETE PAVEMENT

New Top Pressed On Concrete Road

GUNNAR JOHNSON

Chief Engineer, Vacuum Concrete Corp., New York, N. Y.

A mile of old concrete road has a new top pressed on, with a force of 1,500 lb. per sq. ft., by air pressure on vacuum mats

CONTRASTING SHARPLY with the customary practice of making concrete resurfacing 4 or 5 in. thick, a test topping installation 3,500 ft. long, and only 2 in. thick on the tangents recently was opened to traffic on Pennsylvania State Route 59 (U. S. Route 322) a short distance west of Grampian, Clearfield County, Pa. The theory behind the experiment is: If a new concrete finish can be made to bond so effectively with the old slab that it becomes in actuality an integral part rather than an added (but separate) layer, a thickness of 2 in. should be adequate. This depth permits the use of a coarse-aggregate concrete, and standard finishing equipment can be used, while the cost as compared to a 4-in. or 5-in. resurfacing is low enough to make concrete generally available for resurfacing within existing maintenance budgets.

The method in general was based on the use of the vacuum concrete process. (*ENR* Dec. 19, 1935, p. 867; Oct. 15, 1936, p. 563; and Mar. 18, 1937 p. 403) utilizing the weight of the atmosphere on vacuum suction mats (about 1,500 lb. per sq. ft.) to force a bond between the new surfacing and the previously roughened and grouted surface of the old slab. At the same time, the removal of the excess mixing water by this process is regarded as an important factor in reducing shrinkage stresses in the thin topping which might otherwise have tended to weaken the bond between the new surfacing and the old pavement.

A section of highway was selected which had several curves and hills, to make the test representative of conditions ordinarily encountered only on a wider range of road. Owing to inadequate superelevation of the existing pavement, as much as 9 in. of concrete was required on some of the curves to fit the new surface to the requirements of modern high-speed travel.

The original road was single-lane construction, with transverse joints usually only where concreting was stopped. Extensive scaling had developed with numerous transverse and diagonal cracks. There was a small amount of breakage, which had been patched with bituminous mixtures. A first step was the removal of all loose scale, as well as most of the remaining original surface of the old slab, even where in good condition, to get rid of oil and grease and to provide a mechanical bond for the new surfacing. An experimental surface roughener was tried which proved entirely sound in principle but not rugged enough in construction for the continuous operation demanded. After the first few days, scarifying was done entirely by hand-operated air hammers, using 2¾-in. star drill bits which effectively scaled off the surface of the concrete. After scarifying, the surface of the road was cleaned with an air blast and then swept with rattan push brooms before concreting.

Fig. 2. Truck mounted pump for creating a vacuum under the compression mats.

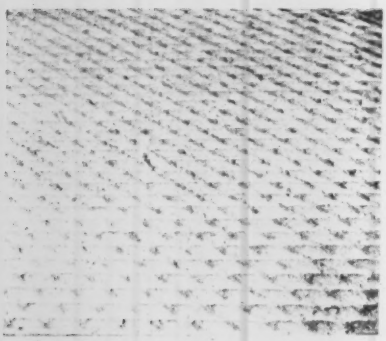


Fig. 3. Expanded metal on the undersurface of the mats produces a non-skid surface.

For the outside edge of the slab 7-in. and 8-in. steel side forms of conventional type were used, being set down into the shoulder of the road as required by the thickness of the new surfacing. While the depth of the new concrete was only a fraction over 2 in. on the straightaways, the correction of superelevation required the full depth of the forms on the curves. For the center forms, 2 x 8-in. planks were used, the new surface being laid in two 9-ft. lanes; holes were drilled 3 in. off the center line of the road about 5 ft. on centers, and wood-plugged, and the planks were spiked to the plugs. The plugs were removed to avoid possible swelling and damage to the slab.

The concrete was a 1:2:3 mix, using ordinary portland cement, sand and crushed stone. It was mixed in a two-sack central mixing plant set-up at one end of the work. Back-dump 1-ton trucks were used to transport the concrete. Because of the thinness of the slab, and the fact that excess water was automatically removed by the vacuum process, the concrete was mixed somewhat wetter than would have been the case for a full-depth slab. The old pavement was thoroughly wetted just ahead of the concreting, and a neat cement grout was thoroughly broomed into the surface, the operation being timed so that the grout did not dry or set before the concrete was placed on it.

A power finisher running on the forms struck off and leveled the concrete ahead of the suction mats which were placed immediately behind the finisher. The mats were 4 x 9 ft. in size, of ½-in. plywood, the surface toward the concrete being covered with an expanded metal having diamonds ¾ x 1½-in. over which a heavy muslin filter fabric was stretched. A sponge-rubber seal around the outer edges of the mats prevented air entry and vacuum loss.

Six mats were used, processing 24 ft. of road, 9 ft. wide, at a time. (Fig. 1). As the mats were under suction an average of 10 min., a speed of about 150 ft. per hour was possible. Several runs of from 750 to 900 lin. ft. were recorded (depending upon the amount of superelevation involved, the added volume of which necessarily slowed down the progress of the work) and one day 1,350 lin. ft. of resurfacing was laid.

The mats were held at the same elevation by a heavy wooden locking bar which spanned the joint between adjacent mats. This locking bar is so designed that, when driven home, it serves to draw adjacent mats together and, in conjunction with a hinged flap on top of the mats, seals the intermediate joints between mats against loss of vacuum. The mats are light, and with the lifting handles provided they were easily placed, moved ahead and reset by two men. At no time was difficulty experienced in vacuum-processing the concrete as fast as it was laid, even on the curves where the full 9-in. of superelevation was vacuum treated.

After placing the mats in position on the fresh concrete, the free end of the suction hose from each mat was plugged into a main suction line laid along the shoulder of the road just outside the forms. This line, of 2¾-in. light weight steel tubing, was fitted with capped nipples every 4 ft. to receive the hose from the mats. Flexible suction-cup connections on the ends of the tubing permitted it to be readily installed and removed without recourse to pipe threading, or use of flanges and gaskets; rubber couplings also permitted sufficient degree of angular movement to meet all requirements of curvature and grade. Vacuum was maintained by a truck-mounted centrifugal vacuum pump. (Fig. 2) on the road shoulder or the old slab a few hundred feet ahead of the work.

As concrete, after vacuum processing, is so hard that it can be walked upon without imprint, to broom the surface is out of the question and any desired non-slip pattern must be impressed on the surface by the suction mats themselves. In this instance, the fabric-covered expanded metal impressed a distinct non-skid pattern of raised diamonds on the surface of the concrete, as shown by Fig. 3.

After processing, the concrete was covered with cotton mats and kept wet for six days before opening to traffic. No reinforcement was used. Old bituminous patches were removed and filled with concrete, and joints were located in the new concrete over all construction joints, and in a straight line as nearly as possible over all major transverse and diagonal cracks.

Some observed results

Both plain and vacuum-processed test beams were cast each day. After the technique of making the vacuum beams had been mastered, the breaks showed from 40 per cent to 50 per cent increase for the vacuum-processed beams. A fair average modulus of rupture was in the neighborhood of 700 lb. per sq. in. for the plain beams and 1,000 lb. per sq. in. for vacuum concrete.

The riding qualities of the road are excellent; as was anticipated, the non-skid surface pattern produces a slight tire hum, which, however, is no more than that resulting on other types of pavement. It is probable that this could be reduced, if so desired, by changes in the size of the diamonds, or by the use of an entirely different surface pattern.

The work was done by state highway department forces under the direction of Seth W. Bloom, district engineer, with C. E. Nicodemus in charge at the job. The vacuum-processing equipment was furnished by the Vacuum Concrete Corporation, New York, and operated under the direction of the author.

Righting a Tipped Culvert

A. R. COLLIER

Superintendent of Bridges, Connecticut Highway Department, East Haddam, Conn.

Good construction and ingenious restoration played equal parts in the quick replacement of a sizable washed-out culvert on one of Connecticut's main highways. The partial failure of the Killingworth Dam following a cloudburst on July 23, as reported in *Engineering News-Record* July 28 and Aug. 4, 1938, piled up water behind the roadfill and finally overtopped and washed out the embankment and dislodged the culvert that passed through it. The damage done is indicated in Fig. 1; Fig. 2 is a schematic diagram of the method of restoring the culvert.

As shown by the illustrations the culvert is a concrete box with wing walls; its dimensions are 10x10 ft. x 64 ft. long and the location is in a 12-ft. fill. Sketch A, Fig. 2, shows the original location, Sketch B, the positions of the culvert parts after the washout, and Sketch C, the position of the restored structure. Referring to Sketch B, the washout moved the downstream end of the culvert about 10 ft. to the left and dropped it about 5 ft. The box rotated to the left about 45 deg. in changing position. The wing walls were shifted as follows: wall *a* undermined and turned over; wall *b* washed downstream about 25 ft.; wall *c* remained in its original position, and wall *d* was undermined and tipped.

The method used to restore the culvert was as follows: A flume of corrugated iron pipe was installed to by-pass the water, and after the bottom of the box had been unwatered, a series of 100-, 75- and 50-ton jacks were placed in suitable clips, provided on the left-hand face. These jacks, in conjunction with cables from the top pulling toward the right, turned the box into an upright position. After this was done, it was necessary to jack the downstream end up about 3 ft. and backfill under it. When the box was brought to a level grade, the upstream end was found to be about 5 in. from its original position; this was jacked laterally to its correct location. The wingwalls on the lower end, one of which was moved about 25 ft. down stream and the other turned over, were removed to permit righting the box, and two new wingwalls were constructed. The roadway fill then was replaced.

This work was done by the Connecticut State Highway Department under the supervision of the writer.

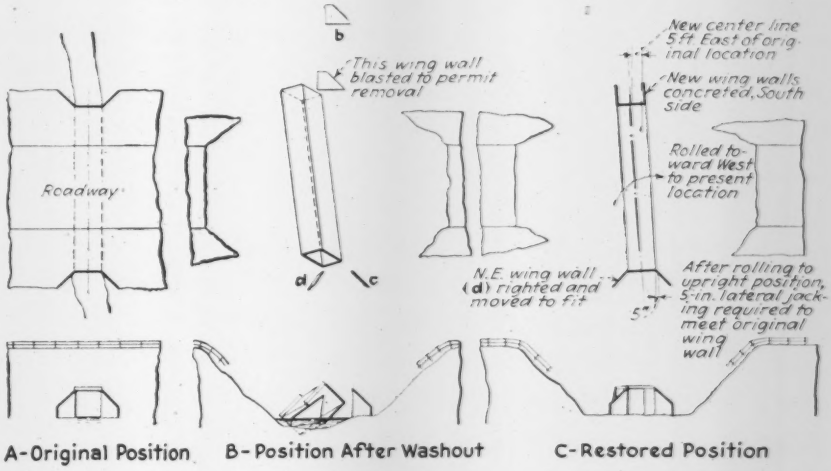

b
This wing wall blasted to permit removal
Roadway
d
c
N.E. wing wall (d) righted and moved to fit
New center line 5 ft. East of original location
New wing walls concreted, South side
Rolled toward West to present location
After rolling to upright position, 5-in. lateral jacking required to meet original wing wall
5"
A-Original Position
B-Position After Washout
C-Restored Position

Fig. 2. Sketches show original, dislodged and restored positions of 10x10x64-ft. box culvert washed out by a dam break

Fig. 1. Concrete box culvert after washout of roadfill near Killingworth, Conn.; view of upstream end at left and of south end at the right emphasize tilt of box that was righted by jacking.

BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

Dreams Come True

FROM PLAN TO REALITY—II—By the Staff of the Regional Plan Association. 108 pp. Published by the Regional Plan Association, 400 Madison Ave., New York. Price, $2.

Vast changes have taken place in the physical development of New York and its environs during the last eight years. Perhaps in no other place has there been a more diversified or larger program of public works improvements, most of which are integrated and form part of a comprehensive plan laid down by the Regional Plan Association. Tunnels, highways, parks and all manner of public service facilities constructed by scores of agencies are represented in the list of accomplishments. Complete information on what has been built and by whom is given in this survey of progress. The book is no mere listing of things and names, but a readable, concise story of guided community growth.

Data on Asphalts

ASPHALTS AND ALLIED SUBSTANCES—Fourth Edition. By Herbert Abraham, 1,491 pp. Published by D. Van Nostrand Company, Inc., New York. Price $12.50.

The fourth edition of this compendium of information on asphalts and allied substances carries 600 more pages than the third edition. Three new chapters have been added covering the following subjects: Bituminous substances admixed with discrete aggregates; bituminous substances dispersed in water; and bituminous substances dissolved in solvents. A number of other chapters, including the bibliography, have been considerably expanded, and the section on methods of testing has been completely rewritten to bring this subject up to date. There are over 200 pages of references which are assembled at the end of the volume instead of being scattered throughout as in earlier editions.

Since publication of the first edition, Asphalts and Allied Substances has been the only reasonably complete treatise in English covering bituminous materials in general. The fourth edition shows marked improvement over earlier editions and will undoubtedly prove to be a valuable reference to technologists specializing in such products.

Surveying

SURVEYING—By Charles B. Breed and the late George L. Hosmer. Volume I, Elementary Surveying, seventh edition; Volume II, Higher Surveying, fifth edition; 717 and 675 pp., respectively. Published by John Wiley and Sons, New York. Price: Vol. I, $4.00; Vol. II, $3.50.

Since the death of his collaborator in the publication of previous volumes, Professor Breed has prepared an enlarged and considerably revised edition of the two volumes of this always-teachable book. As the amount of subject matter increases with the succeeding editions (the first came out in 1904), "Surveying" approaches the comprehensive type of text.

The first volume has been thoroughly reviewed, revisions being made in many parts and problems being added to nearly every chapter. Expansion of the discussion of errors in the first chapter is in line with present trends in teaching. In dealing with the U. S. system of public land surveys, the book perpetuates a common textbook error of assuming that the public land surveys were conducted according to current instructions, when in fact the instructions so liberally quoted were followed in the exceptional case rather than in the surveys of the most densely settled parts of the public land states. This text would be much more valuable if it gave a brief discussion of the actual manner of the early surveys, and omitted the extensive quotations which are available in U. S. General Land Office circulars and manuals.

In the second volume, covering higher surveying, several chapters have been revised, so that the two books together cover the work of elementary and advanced surveying quite thoroughly. The revision of the chapter dealing with control surveys and photogrammetric methods makes the book conform to current recommended surveying curricula for engineering colleges. The same is true of the material dealing with stream gaging.

Measuring Efficiency

MEASURING MUNICIPAL ACTIVITIES—By Clarence E. Ridley and Herbert A. Simon. 102 pp. Published by the International City Managers' Association, Chicago. Price $2.

How can we measure efficiency in the administration of municipal activities? Simple units or indices which automatically evaluate results are not only inadequate but they also misrepresent and confuse, according to Messrs. Ridley and Simon. Consequently, they set out to devise techniques by which to appraise and compare results of governmental activities. Their system of measurement is based on information obtained by the use of carefully developed records and the establishment of certain criteria of achievement. Applications of the system are illustrated in connection with fire, police, public works, health, recreation, welfare, education, library, personnel, municipal finance and city planning activities. A list of 29 suggested report forms is given so that the measurement technique described can be put into practical use.

Swimming Pool Sanitation

MINIMUM SANITARY REQUIREMENTS FOR SWIMMING POOLS AND BATHING PLACES—56 pp. Published by the Division of Sanitary Engineering, State Department of Public Health, Springfield, Ill.

This revised edition has been prepared under an Illinois law which gives the State Department of Public Health supervision over swimming pools, including those for general public use as well as those for institutions, country clubs and other organizations. The specific requirements are printed in bold type, and each is supplemented by explanations and more detailed information as to the purposes of the requirements and the

ways in which they may be met or attained.

Shape, size, slope and construction materials of the pool are discussed, together with the varied equipment. Sand beaches for children in wading pools are not approved. Water supply receives extended attention, also cross-connections, circulation and supply for various supplemental purposes. Typical regulations for operation and control are presented. In view of the increasing development in the use of swimming pools, this pamphlet is a useful addition to the literature dealing with the principles and problems of effective design and safe and sanitary operation.

Welding Research

WELDING OF STEEL STRUCTURES—Report of the Welding Panel, Steel Structures Research Committee, Dept. of Scientific and Industrial Research, Great Britain. 326 pp. Obtainable from the British Library of Information, 270 Madison Ave., New York. Price $1.75.

In this 300-page book, the Welding Panel of the British Steel Structures Research Committee does for British welding what the American Welding Society accomplished for welding in this country seven or eight years ago. First, there is included a statistical examination of the strength of welded joints, based upon nearly 2,000 tests performed on welded samples supplied by 66 British firms. From all of this work it is concluded that the nature of the electrode is probably the most important factor in determining the strength and other properties of a weld, and that next in importance is workmanship. A second investigation of non-destructive methods of testing welds leads to the conclusion that none of the present methods is satisfactory for structural welding, but that welding may be satisfactorily carried out assuming thorough inspection and supervision during the course of the work. Furthermore, such supervision, it is concluded, should be supplemented by periodic tests on both fillet welds and butt welds to test the workman's ability. The third part of the investigation was concerned with fatigue resistance of welded joints from which it is concluded that the possibility of fatigue failure need not be considered in buildings of normal type but that careful investigation is necessary where heavy moving machinery is involved. Finally, the report presents a survey of existing published information on the design of welded joints.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

THE PRINCIPLES AND PROPER PRACTICES in designing steel plate floors are presented in a 25-page booklet, "The Battledeck Floor for Highway Bridges," available without charge from the American Institute of Steel Construction, 200 Madison Avenue, New York City. The design data, presented in the form of tables, are based upon an extensive test program carried out at Lehigh University. Drawings of structural details as well as recommended design specifications are included.

BASIC PRINCIPLES OF HEALTHFUL HOUSING, a preliminary report by the Committee on the Hygiene of Housing, American Public Health Association, considers those elements of healthfulness which must be provided in the design, construction and management of new housing developments. Copies may be had from the association, 50 W. 50th St., New York, at 25c. each.

FATIGUE TESTS OF RIVETED JOINTS is the subject of Bulletin No. 79, Engineering Experiment Station, University of Illinois, Urbana, Ill. The study was made in cooperation with the Department of Public Works of California as research in connection with the San Francisco-Oakland Bay Bridge.

TESTS ON A PRECAST-SLAB FLOOR PANEL are described in Technical Bulletin No. 1, Armour Institute of Technology, Chicago. The slab was built according to designs of White Steel Monolithic Systems, Inc.

UNION WAGE SCALES OF BUILDING TRADES in 70 cities are listed in Bulletin No. 657, U. S. Dept. of Labor. Obtainable from the Supt. of Documents, Washington. Price 10c.

THE GRADING OF AGGREGATES and Workability of Concrete have been made the subject of Technical Paper No. 5, Road Research, Ministry of Transport (Great Britain). Copies may be obtained from the British Library of Information, 270 Madison Ave., New York City. Price 45c.

RECENT FACTS on motor vehicle transportation are contained in "Automobile Facts and Figures—1938 Edition," published by the Automobile Manufacturers Association, 366 Madison Ave., New York City.

CANADIAN SPECIFICATIONS for Steel Highway Bridges are given in a third edition of the standard specifications issued by the Canadian Engineering Standards Assn., Ottawa, Ont. Price 50c.

NEW PUBLICATIONS

TRADE ASSOCIATIONS IN LAW AND BUSINESS—By Benjamin S. Kirsh in collaboration with Harold Roland Shapiro. 399 pp. Published by the Central Book Co., New York. Price $5.

WOOD PIPE HANDBOOK—269 pp. Published by the National Tank & Pipe Co., Kenton Station, Portland, Ore. Price $2.50.

STREET CLEANING PRACTICE—By the Committee on Street Cleaning. 407 pp. Published by the American Public Works Association, Chicago. Price $4.

TRATAMIENTO DE LAS AGUAS Y LIQUIDOS CLOACALES—576 pp. Prepared and published by Obras Sanitarias de La Nacion, Buenos Aires, Argentina.

A HISTORY OF TRANSPORTATION IN CANADA—By G. P. deT. Glazebrook. 475 pp. Published for the Carnegie Endowment for International Peace by the Ryerson Press, Toronto, and Yale University Press, New Haven, Conn. Price, $4.

GEODETIC BULLETINS—March-October, 1938. Approx. 200 pp. each. Published by the Mass. Geodetic Survey, 100 Nashua St., Boston, Mass.

SIXTIETH ANNUAL REPORT OF THE DEPARTMENT OF HEALTH OF THE STATE OF NEW JERSEY—411 pp. Published by the Department of Health, Trenton, N. J.

ALPHA CEMENT—How To Use It—112 pp. Published by the Alpha Portland Cement Co., Easton, Pa.

STRING-LINING OF RAILWAY CURVES—P. E. Knight. 117 pp. Published by The Railway Gazette, 33 Tothill St., Westminster, London, S. W. 1. Price 7s.6d.net.

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill

A Novel Detour

N. R. SACK
Bridge Engineer, Missouri State Highway Department, Jefferson City, Mo.

In replacing the floor on four steel through spans (one 302 ft. and three 419 ft.) of the Missouri River bridge at St. Charles, Mo., road traffic was kept moving by the rolling overpass bridge illustrated. The road bridge has a 19-ft. roadway and the old floor was of concrete T-beams carried directly on the main floor beams. As no material could be dropped into the river, this concrete floor had to be broken up and carted away piecemeal. The new floor consists of three lines of steel stringers carrying 10-in. wide-flange beams spaced 3½ ft. that carry in turn a concrete-filled steel-grid deck slab 3½ in. thick welded to the 10-in. beams. Both removal and new work required the full width of the roadway.

It was, therefore, decided to use a movable truss to carry traffic over the floor construction. The truss is 72½ ft. long c. to c. of end bearings. This length is sufficient to span three panels permitting the removal of the old floor and the placement of the new with one setting of the overpass. The width of the overpass span was made as narrow as possible (10¾ ft. c. to c. of trusses) to provide all possible working space alongside of it for handling materials. It has a laminated 2x6-in. timber deck providing a clear roadway width of 7 ft. between curbs. The clearance between roadway grade and low steel is 18 in. Each end of the trusses is carried by two steel rollers 16 in. in diameter and 12 in. wide. Access to the overpass is provided by timber ramps about 25 ft. long.

Two overpasses were used, spaced 250 ft. apart. With traffic movements coordinated and controlled by traffic officers, traffic experienced very little delay.

George Owen is superintendent for the contractors, the Massman Construction Co. of Kansas City, Mo. The work is under the supervision of C. W. Brown, chief engineer of the Missouri highway department with George Morgan as project engineer.

Rolling overpass span detours traffic past work on new bridge floor

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Wire Screens For Scaling Cliffs

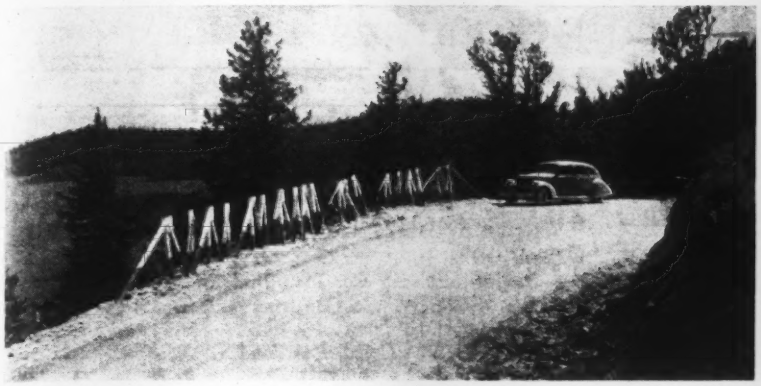
E. A. COLLIER
Division Engineer, Oregon State Highway Commission, Portland, Ore.

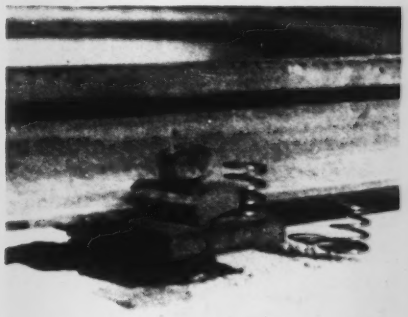
Wire screens were tried out this spring by the Oregon State Highway Commission as a means of minimizing the danger from falling rocks on the famous Columbia River highway where it skirts overhanging bluffs. During spring thaws, material ranging from small gravel to boulders weighing up to 300 lb. becomes loosened from a rather poorly cemented gravel layer 30 ft. thick near the top of a bluff 100 ft. above the pavement. At times the situation became so dangerous that there was serious hazard to traffic and considerable damage to pavement scarred and roughened by the impact of falling rocks.

Fig. 1. Wire screens placed to keep falling rock off the highway that skirts the foot of the cliff.

To effect a remedy experienced slopers, suspended on ropes, combed all loose rock from the bluff while traffic was detoured. At two of the worst locations safety screens of heavy galvanized wire fencing with a 2-in. diamond mesh were fastened in place. The strips were sewed together with galvanized wire until an assembly was made 185 ft. long by 150 ft. high. The upper edge is supported with messenger cable fastened to trees. The screen rests on the bluff which has a slope of 1 on ½ and is fastened at the bottom with cables, so that the screen cannot be thrown out as far as the edge of the pavement. Loosened boulders are expected to roll down between the bluff behind the screen to the inside road ditch.

Another screen, 230 ft. long by 35 ft. high was placed where gravel rests on 1 on 1 slope. In this case the screen is pinned down with ¾-in.





CAMERA MEMORANDA

1. In Colorado some road engineer who had parts of dismembered steel trusses on his hands solved his disposal problem by setting them in the ground to make a highway guard rail.

2. In setting rails for Dorr clarifier plowing equipment at the Calumet sewage works in Chicago exact level was secured by supporting the rail on coil springs, screwing down the anchor bolts to exact elevation, shimming up and grouting under the rail.

bolts 2 to 3 ft. long, driven into the bank at frequent intervals. Top and bottom are fastened with messenger cables tied to dead men. This slope will be planted to ivy and it is expected that such gravel as may be loosened in the future will not be further displaced.

The cost of these screens has been about 37c. per sq.yd. of screen in place. R. H. Baldock is state highway engineer; W. M. Strohmeyer, maintenance superintendent, was in charge of the screening operations.

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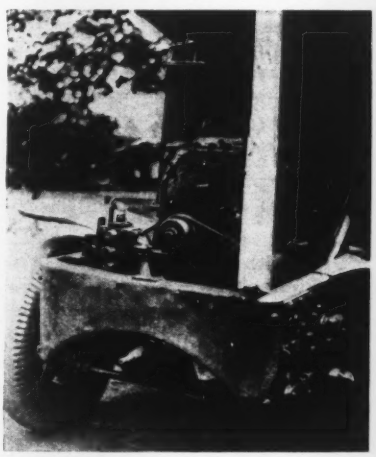
Brake Booster for Trucks

Six days a week, the trucks for the New Riverside Ochre Co., Cartersville, Ga. carry from 400 to 1,000 tons of barytes a day. This rock has a specific gravity of 4.3 and is used as a substitute for white lead. When the loaded trucks rolled down the winding hills, it was almost impossible to control them with ordinary brakes. The chief mechanic of the company had an idea. He devised a power brake by salvaging an oil hoist pump from an old dump truck and mounting it in the chassis to one side of the diesel. The pump, driven by a fan belt, is attached to and capable of applying 300 lb. pressure to the master brake cylinder. As a safety measure because of the tremendous pressures that the pump can produce uncontrolled, a by-pass valve is set just below the point at which the brake rod will snap.



Oil pump supplements regular brake on diesel powered trucks.

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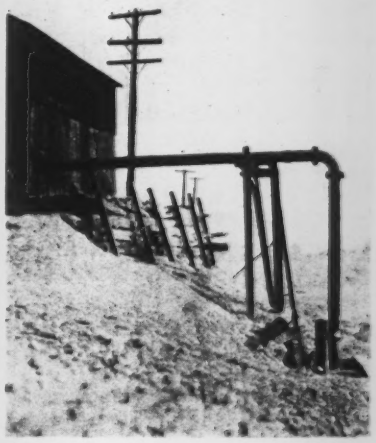
A Hint For Pump Priming

K. B. HUMPHREY
Sayerville, N. J.

The centrifugal pump must have the suction line and the pump itself completely filled with water before it will work. To be able to fill the pump, previous to starting, a check valve is placed at the end of the suction pipe below the water level. When clear water is being pumped very little trouble is experienced with this arrangement, but when the water is muddy or where chips of wood can occasionally get in, a small stone or chip gets lodged in the valve and does not permit it to close tightly. Then a handy arrangement is shown by the accompanying illustration.



Arrangement for priming a pump when the foot-valve leaks.

The flanged joint near the water line is taken apart, one bolt being left in so that the suction pipe and foot valve does not drop down. This gives access above the foot valve. Three or four shovels of sand and clay or loam are put in above the valve and then a bucket or two of water. The sand clogs the leak and the foot valve will then hold water. The joint is made up again and the pump primed by a bucket at the discharge end of the pump. One man can easily handle the whole operation. When the pump starts the sand is discharged without any trouble.

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

MACDONALD CREEK BRIDGE, WASHINGTON

OWNER: Washington State Department of Highways; L. V. Murrow, director.

PROJECT: Constructing MacDonald Creek bridge and channel change, located in Clallam County as a part of state primary route No. 9. Bridge is of treated pile and timber trestles surmounted by a 28-ft. concrete roadway slab of thickness varying from 5½ to 7 in. Total length is 179 ft., consisting of eight spans of 17 ft. and of one span of 36 ft. Bridge must clear channel 44 ft. at center line. Concrete cost is low because of small amount of formwork required. The slab rests upon timber stringers, with bottom forms anchored and supported between these stringers. Transportation facilities by highway and water are available. Stipulated contract time is 150 calendar days. Wages are as follows: skilled, $1.20 per hr.; semi-skilled, 75c. per hr.; common, 50c. per hr.

BIDS: Three bids were received Sept. 7, 1938, ranging from the contract low of $23,942 to $35,420.

LOW BIDDERS:

1. F. E. Wilder, Olympia (contract) $23,942
2. Allen & Goven, Inc., Olympia 26,767
3. L. Coluccio, Seattle 35,420

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Uncl. excav. incl. haul	21,470 c. y.	$0.20	$0.23	$0.45
2. Struct. excav. incl. haul	20 c. y.	1.00	1.50	1.50
3. C. conc. pav. br. appr. slabs (cl. "A")	31 c. y.	16.00	22.50	20.00
4. S. reinf.	5,000 lb.	.06	.06	.05
5. Reinf. conc. gutter	10 l. f.	2.00	1.00	.75
6. Cl. "B" riprap	1,130 c. y.	3.00	3.50	5.00
7. Hand placed riprap	1 c. y.	10.00	6.00	7.50
8. Spec. conc. inlet with C.I. fr. and gr.	L. S.	50.00	65.00	60.00
9. Remov. exist. reinf. conc. pav., gutter	460 s. y.	.30	.65	1.50
10. Remov. exist. cable guard rail	500 l. f.	.10	.15	.15
11. Remov. exist. wood flume	64 l. f.	.10	.10	.15
12. Reset. cable guard rail	100 l. f.	.50	.50	.25
13. Dip. corr. iron pipe No. 16 ga. 8 in.	68 l. f.	1.00	.75	1.00
14. Struct. excav.	400 c. y.	1.50	2.00	3.00
15. Conc. cl. "A"	140 c. y.	20.00	22.50	26.00
16. Conc. cl. "B"	38 c. y.	20.00	22.50	26.00
17. S. reinf.	32,000 lb.	.06	.06	.06
18. Struct. metal compl.	1,700 lb.	.10	.10	.20
19. Lumber (creos. tr.)	46 M.b.m.	80.00	95.00	95.00
20. Tbr. and lumber (zn. chl. tr.)	1 M.b.m.	80.00	95.00	95.00
21. Tr. tbr. piling	3,200 l. f.	.70	.65	.60
22. Driv. tr. tbr. piles	64 ea.	12.00	13.00	15.00
23. Furn. and driv. test piles	2 ea.	50.00	70.00	75.00
24. Cast steel drains compl.	4 ea.	20.00	25.00	30.00
25. Reflector units compl.	4 ea.	10.00	5.00	7.50
26. Reinf. conc. br. railing	363 l. f.	4.00	4.00	4.50
27. Remov. portion of exist. conc. culv.	60 c. y.	6.00	5.00	15.00

HIGHWAY PAVING, NEW YORK

OWNER: New York State department of public works.*

PROJECT: Reconstruction and construction on the Keuka-Penn Yan road. Project length is 5.49 miles, consisting of 3.37 miles of reinforced concrete and 2.12 miles of gravel surfaced bituminous treated road. Pavement is to be 22 ft. wide and total roadway width 36 ft. Concrete is of 8-7-8-in. thickness laid over an 8-in. foundation course and a 4-in. bottom course. Transportation by rail and highway is available. Completion date is Dec. 1. 1939.

BIDS: Eight bids were received Oct. 4, 1938, ranging from $268,067 to $316,118.

LOW BIDDERS:

1. Mohawk Paving Co. Inc., Buffalo $268,067
2. Bero Engineering & Construction Corp., North Tonawanda, N. Y. 272,443
3. Potter-DeWitt Corp., Pavilion, N. Y. 279,957

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Clear grub	L. S.	$2,500.00	$2,500.00	$2,500.00
2. Uncl. excav.	139,500 c. y.	.20	.20	.23
3. Tr., cul. br. excav.	16,380 c. y.	.60	.45	.60
4. Overhaul	187,000 sta. y.	.0025	.005	.005
5. Trim. Shoulders	29,560 l. f. rd.	.11	.10	.10
6. Prep. fine grade	72,645 s. y.	.10	.10	.10
7. 12-in. sewer pipe	50 l. f.	.75	.85	.75
8. 18-in. sewer pipe	150 l. f.	1.25	1.40	1.50
9. 6-in. pipe underdrain	27,450 l. f.	.20	.25	.20
10. 24-in. CMP	1,502 l. f.	3.90	4.75	4.50
11. 30-in CIP	248 l. f.	6.25	7.50	7.50
12. 12 ft. 6-in.-CIP	115 l. f.	48.00	50.00	50.00
13. 12-in CMP	162 l. f.	1.75	1.75	1.50
14. 18-in. CMP	2,400 l. f.	2.75	2.80	2.75
15. Portland cem.	16,530 bbl.	2.25	2.20	2.10
16. Natural cem.	2,215 bbl.	2.75	2.70	2.70
17. Conc. for struct. 1-2-3½	1,140 c. y.	14.00	14.00	15.00
18. 1st cl. conc. 1-2-4	353 c. y.	15.00	15.00	18.00
19. 2nd cl. conc. 1-2½-5	450 c. y.	11.00	12.00	13.00
20. 3rd cl. conc. 1-3-6	10 c. y.	8.00	10.00	10.00
21. Loose stone backing	230 c. y.	2.00	2.50	2.00
22. Reinf. for pavt.	43,470 s. y. p.	.23	.24	.22
23. Joint supports	5,018 ea.	.45	.50	.45
24. Bar reinf. for struct.	122,000 lb.	.045	.045	.045
25. Misc. iron and steel	5,920 lb.	.08	.10	.07
26. Reset. cable guide rail	400 l. f.	.50	.40	.35
27. Cable guard rail	6,250 l. f.	.85	.95	.85
28. Reset guide posts	80 ea.	.50	.50	.50
29. Guide posts	900 ea.	2.25	2.50	2.50
30. Metal rail	40 l. f.	4.00	4.75	4.00
31. Fnd. crse. ROB grav.	14,650 c. y.	.90	.85	.90
32. Fnd. crse. ROB grav. LM.	505 c. y.	.75	.80	.75
33. Bot. crse. ROB grav.	3,235 c. y.	1.20	1.25	1.00
34. C. conc. pavt.	9,075 c. y.	4.75	5.00	5.00
35. Bit. mat. waterproof	800 gal.	.40	.50	.50
36. Maint. traff. at culv.	L. S.	785.00	785.00	785.00
37. Maint. traff.	33,120 l. f.	.10	.10	.10
38. Maint. traff. for BM.	1,050 l. f. rd.	.20	.20	.20
39. Prot. of traff.	L. S.	1,200.00	1,200.00	1,200.00
40. Dry riprap	70 c. y.	3.50	2.50	3.00
41. Grouted riprap	10 c. y.	4.00	4.00	4.00
42. Remov. ex. br. superst.	L. S.	50.00	50.00	50.00
43. Cofferdams, etc.	L. S.	600.00	600.00	600.00
44. Screened gravel, LM No. 2 and 3A	8,520 ton	1.20	1.10	1.35
45. Conc. gutter	75 s. y.	1.40	1.40	1.40
46. Conc. ROW markers	220 ea.	2.50	2.50	2.50
47. Conc. sidewalks	10 s. y.	1.00	1.50	1.50
48. Lumber	4 m.b.m.	50.00	50.00	50.00
49. Relaying old pipe	260 l. f.	.25	.25	.25
50. Topsoil	3,130 c. y.	.80	1.00	1.00
51. Seeding	17,650 s. y.	.04	.05	.05
52. Sod	21,000 s. y.	.40	.40	.50
53. ROB gravel, LM.	250 c. y.	1.00	1.00	.75
54. Treat. with BM, TCA	14,700 gal.	.11	.13	.12
55. Screened gravel, LM No. 1.	274 ton	1.50	1.35	1.35
56. Extra compacting	29,645 l. f. rd.	.10	.10	.10

SHEET PILE DOCK WALL, MILWAUKEE

OWNER: Milwaukee Board of Harbor Commissioners; C. U. Smith, engineer.

PROJECT: Constructing 1,193 ft. of sheetpile dockwall to strengthen the existing dockwall along Kinnickinnic River. This work comprises furnishing and driving of 50-ft. steel sheet piling and anchoring some to old dock wall and new wood piles. The space between the old dock and new steel sheetpiling is to be filled with sand. A concrete cap, approximately 4.88 ft. deep and varying in width from 5.17 ft. to 8.81 ft., is to be placed above the sand fill (concrete 1:2:4). The water depth alongside of dock is about

(Contract Unit Prices continued on second following page)

* Unit prices courtesy *The Low Bidder*, official publication of the New York State Highway Chapter, Inc., A.G.C.